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DrägerService®

Dräger

# Technical Service Manual

Part Number: 4111556-001
Rev: AB
Date: 20 May 2002
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## Narkomed 4
## Anesthesia System

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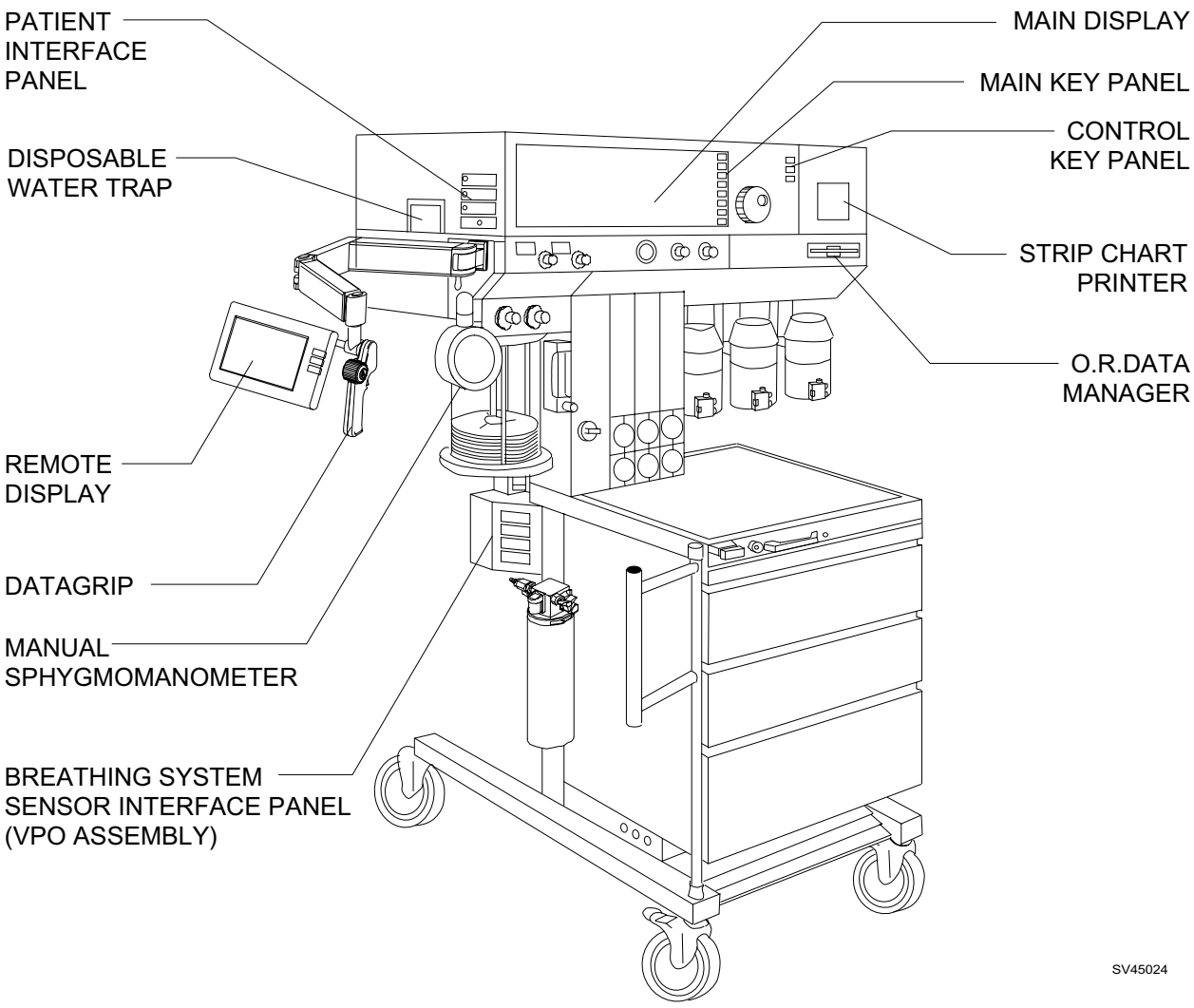
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## NARKOMED 4 ANESTHESIA SYSTEM



## 1.0 Recommendations

Because of the sophisticated nature of Draeger Medical, Inc. anesthesia equipment and its critical importance in the operating room setting, it is highly recommended that only appropriately trained and experienced professionals be permitted to service and maintain this equipment. Please contact DrägerService® at (800) 543-5047 for service of this equipment.

Draeger Medical, Inc. also recommends that its anesthesia equipment be serviced at three-month intervals. Periodic Manufacturer's Service Agreements are available for equipment manufactured by Draeger Medical, Inc. For further information concerning these agreements, please contact us at (800) 543-5047.

**Draeger Medical, Inc. products/material in need of factory repair shall be sent to:**

**DrägerService**
**3124 Commerce Drive**
**Telford, PA 18969**
**(Include RMA Number)**

### HOW TO USE THIS MANUAL

The manual is divided into several sections. The DIAGNOSTICS section describes self-test and service diagnostics for checking the system functions. An understanding of the on-board service capabilities is necessary before any attempt is made to troubleshoot the unit. The TROUBLESHOOTING section lists error codes and provides troubleshooting guides to assist the TSR in locating the source of a problem. The REPLACEMENT PROCEDURES section contains instructions for removal and replacement of the assemblies that are considered field-replaceable. The ADJUSTMENT AND CALIBRATION PROCEDURES section contains the field procedures needed to restore original system specifications. The Periodic Manufacturer's Service (PMS) PROCEDURE section outlines the steps required to verify the electrical, mechanical and pneumatic safety of the unit and also identifies components requiring periodic replacement.

### GENERAL TROUBLESHOOTING GUIDELINES

Troubleshooting the Narkomed 4 should always begin by communicating with those who observed or experienced a problem with the unit. This may eliminate unnecessary troubleshooting steps. Once a general problem is identified, refer to the troubleshooting flow charts in Section 3 to determine the proper corrective action to be taken.

After a component has been replaced, verify that the unit is operating properly by running the appropriate diagnostic procedure. The PMS PROCEDURE in Section 6 must also be performed after any component has been replaced.

The general arrangement of the Narkomed 4 Anesthesia System is shown on the opposite page.

**WARNINGS** are used in this manual before procedures which if not performed correctly could result in personal injury.

**CAUTIONS** are used in this manual to alert service personnel to the possibility of damage to the equipment if a procedure is not performed correctly.

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## Disclaimer

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## 2.0 DIAGNOSTICS

The NARKOMED 4 contains a diagnostic system that monitors certain system functions and records their operational status. A series of tests is performed when the system is powered up and the results are displayed on the diagnostics screen shown in Figure 2-1. Further diagnostic functions are available through a series of service screens that can be called up by a Technical Service Representative at the display panel. The following paragraphs provide a description of each of the service screens that can be accessed through touch keys on the display panel. If no display is present upon system power-up, refer to Section 3 of this manual for troubleshooting assistance.

A PREVENTIVE MAINTENANCE DUE message will appear on the screen if the current date exceeds the Periodic Manufacturer's Service due date stored in the machine.

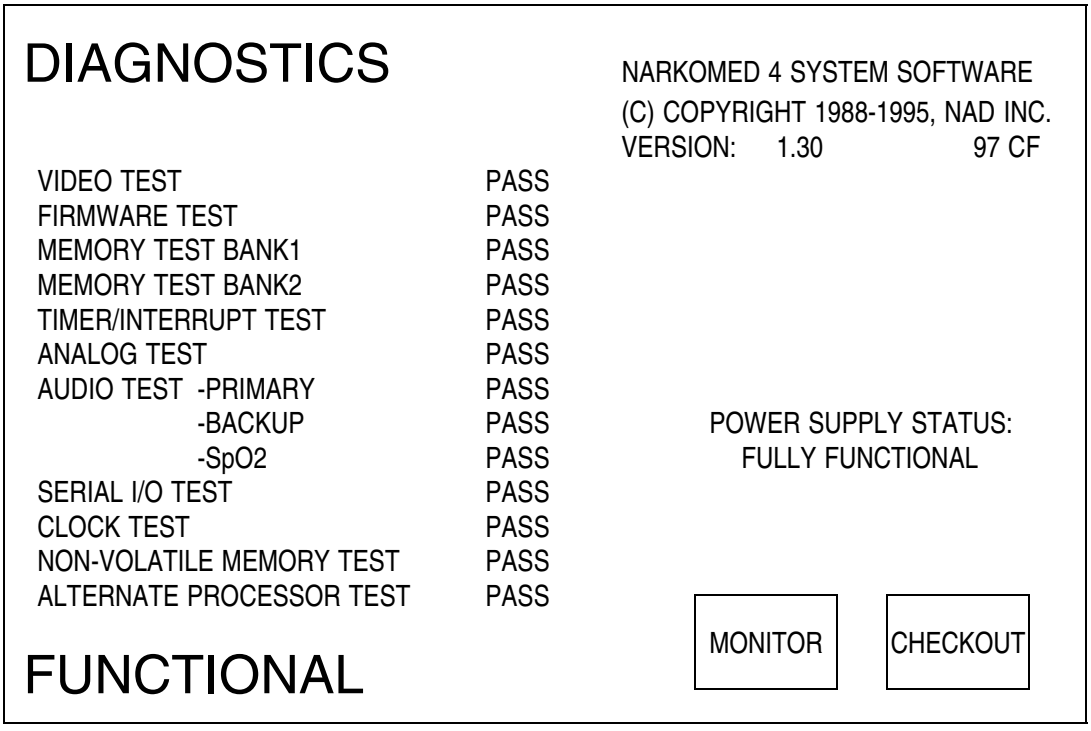



**Figure 2-1: POWER-UP DIAGNOSTICS SCREEN**

## 2.1 Main Service Screen

### 2.1.1 View Mode

To access the Main Service Screen, press and hold the Selection DIAL, and simultaneously press the MONITOR and SYSTEM CONFIG keys. The View mode service screen shown in Figure 2-2 will appear, displaying the machine serial number, last service date and machine hours accumulated. Version numbers for each software set in the machine are also displayed.

If the MONITORS service screens are accessed in the View mode, current values will be displayed but the operator will not be able to perform calibrations. A VIEW entry will not be logged into the Service Log.

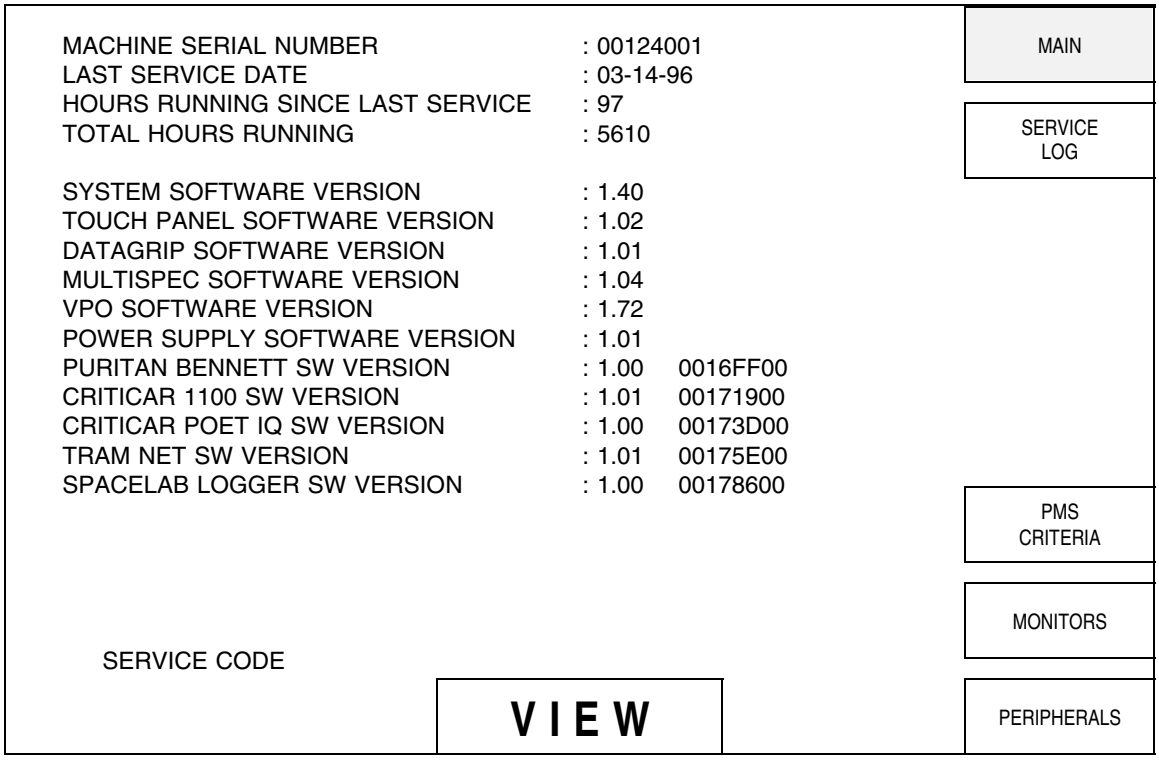

MACHINE SERIAL NUMBER : 00124001
LAST SERVICE DATE : 03-14-96
HOURS RUNNING SINCE LAST SERVICE : 97
TOTAL HOURS RUNNING : 5610
SYSTEM SOFTWARE VERSION : 1.40
TOUCH PANEL SOFTWARE VERSION : 1.02
DATAGRIP SOFTWARE VERSION : 1.01
MULTISPEC SOFTWARE VERSION : 1.04
VPO SOFTWARE VERSION : 1.72
POWER SUPPLY SOFTWARE VERSION : 1.01
PURITAN BENNETT SW VERSION : 1.00 0016FF00
CRITICAR 1100 SW VERSION : 1.01 00171900
CRITICAR POET IQ SW VERSION : 1.00 00173D00
TRAM NET SW VERSION : 1.01 00175E00
SPACELAB LOGGER SW VERSION : 1.00 00178600
SERVICE CODE
VIEW
MAIN
SERVICE LOG
PMS CRITERIA
MONITORS
PERIPHERALS

**Figure 2-2: VIEW MODE SERVICE SCREEN**

### 2.1.2 Service Mode

Touch the Service Code box on the screen, then scroll through the following list of service codes with the Selection DIAL:

PMS: When performing scheduled Periodic Manufacturer's Service.
INST: For initial installation of the NM4. This selection will establish the start date for the warranty period.
SRVC: For unscheduled service visits requiring component replacements or calibrations.

Press the Selection DIAL to enter the service event into the Service Log. The Technical Service Representative ID boxes will appear on the screen as shown in Figure 2-3. Touch the first box, scroll to the desired alpha-numeric with the Selection DIAL, and press the dial to enter the first character of the ID. Enter the remaining three characters in the same manner.After the ID has been entered, the RESET key will be displayed.

NOTE: Following any service procedures, return to this screen and touch the RESET key to enter the current date as the last service date, and to reset the Hours Running Since Last Service to zero. Touching the RESET key also places an entry into the service log.

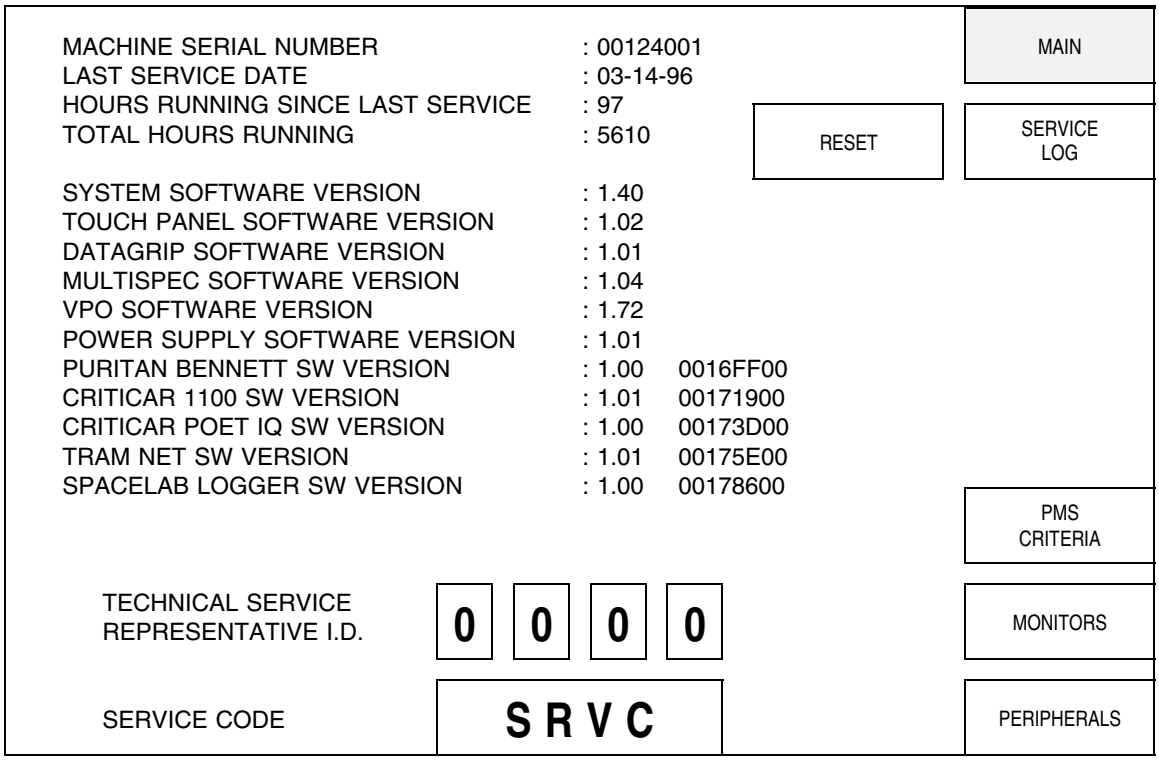

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CRITICAR 1100 SW VERSION : 1.01 00171900
CRITICAR POET IQ SW VERSION : 1.00 00173D00
TRAM NET SW VERSION : 1.01 00175E00
SPACELAB LOGGER SW VERSION : 1.00 00178600
RESET
MAIN
SERVICE LOG
PMS CRITERIA
MONITORS
PERIPHERALS
TECHNICAL SERVICE REPRESENTATIVE I.D.
0 0 0 0
SERVICE CODE
S R V C

**Figure 2-3: SERVICE MODE SERVICE SCREEN**

## 2.2 Service Log Screen

Touch the SERVICE LOG key to display a list of stored events. Figure 2-4 shows a typical service log screen. The codes displayed are classified as Normal Events, Failed Events, Error Events, Service Events, and Calibration Events. These are listed in Tables 2-1 thru 2-6.

Up to 1000 events may be logged. Touching the PREV PAGE key will move the display backward in time; touching the NEXT PAGE key will move the display forward in time.

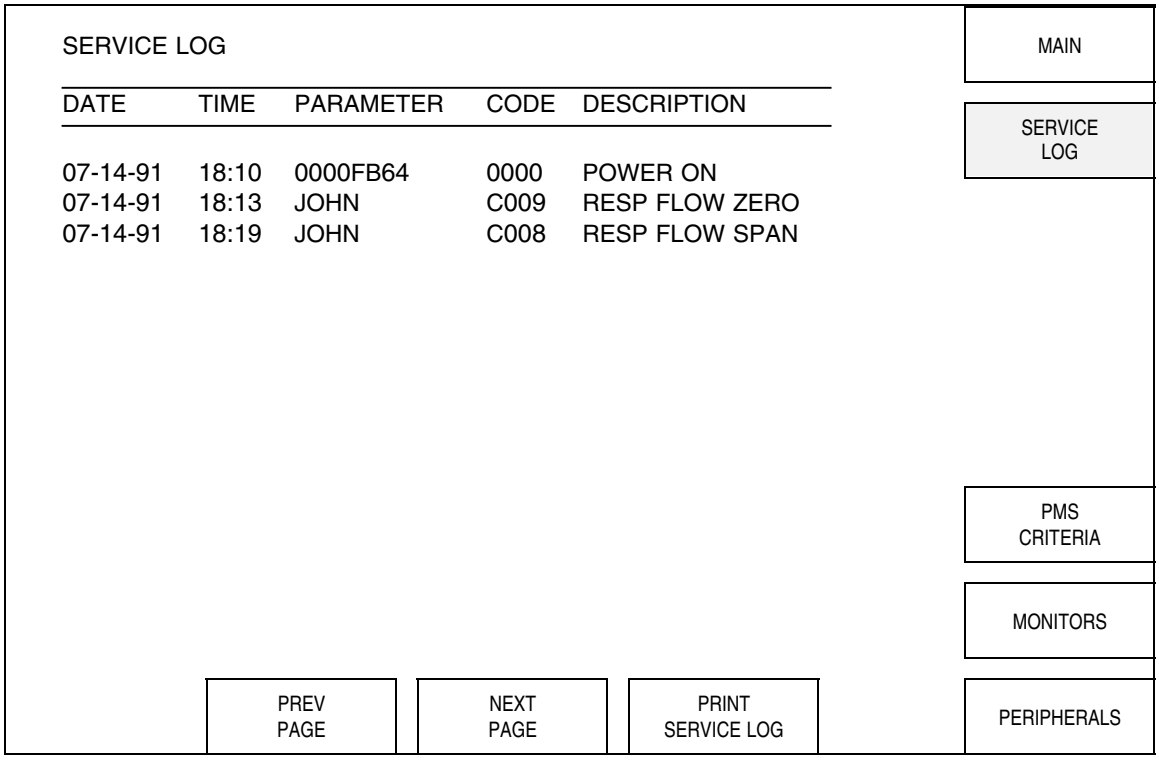



**Figure 2-4: SERVICE LOG SCREEN**

**Table 2-1: NM4 SERVICE LOG NORMAL EVENT CODES**

| Code | Description |
|---|---|
| 0000 | Power on |

**Table 2-2: NM4 SERVICE LOG FAILED EVENT CODES**

| Code | Description | Recommended Action |
|---|---|---|
| F011 | QPDM Address Register Error | Replace Processor |
| F012 | QPDM Data Register Error | |
| F013 | QPDM Vblank Int Timeout Err | |
| F014 | QPDM VRAM Memory Error | |
| F021 | PROM CRC Test Error | |
| F031 | SRAM Memory Test Error | |
| F051 | MFP Bus Error | |
| F052 | MFP TimerA Error | |
| F053 | MFP TimerB Error | |
| F054 | MFP TimerC Error | |
| F055 | MFP TimerD Error | |
| F056 | System Clock Error | |
| F057 | FIFO Empty Interrupt Error | |
| F058 | ADC Interrupt Error | |
| F059 | CNTOVF Interrupt Error | |
| F061 | ADC Interrupt Error | |
| F062 | 12V to -12V Out of Tol Error | |
| F063 | 5V to GND Out of Tol Error | |
| F071 | Pri Spkr Static Test Error | |
| F072 | Pri Spkr Dynamic Test Error | |
| F073 | Pri Spkr FIFO Test Error | |
| F074 | Pri Spkr No Vol Test Error | |

**Table 2-2 (continued): NM4 SERVICE LOG FAILED EVENT CODES**

| Code | Description | Recommended Action |
|---|---|---|
| F081 | Backup Spkr Dynamic Test Err | Replace Processor |
| F082 | Backup Spkr No Vol Test Err | |
| F091 | SAO2 Spkr Static Test Error | |
| F092 | SAO2 Spkr Dynamic Test Error | |
| F093 | SAO2 Spkr No Vol Test Error | |
| F111 | Real Time Clock Test Error | |
| F121 | Bad File Warning | |
| F122 | Bad Files Error | |
| F123 | Event Memory Error | |
| F130 | Alt Processor Fail | |
| F200 | UART1 Internal Init Fail | |
| F201 | UART1 Register Readback Fail | |
| F202 | UART1 Transmit Interrupt Fail | |
| F203 | UART1 Receive Interrupt Fail | |
| F204 | UART1 Receive Err Int Fail | |
| F205 | UART1 Baud Rate Test 1 Fail | |
| F206 | UART1 Baud Rate Test 2 Fail | |
| F207 | UART1 Baud Rate Test 3 Fail | |
| F210 | UART1 Channel 0 Fail | |
| F211 | UART1 Channel 1 Fail | |
| F212 | UART1 Channel 2 Fail | |
| F213 | UART1 Channel 3 Fail | |

**Table 2-2 (continued): NM4 SERVICE LOG FAILED EVENT CODES**

| Code | Description | Recommended Action |
|---|---|---|
| F214 | UART1 Channel 4 Fail | Replace Processor |
| F215 | UART1 Channel 5 Fail | |
| F216 | UART1 Channel 6 Fail | |
| F217 | UART1 Channel 7 Fail | |
| F300 | UART2 Internal Init Fail | |
| F301 | UART2 Register Readbk Fail | |
| F302 | UART2 Transmit Interrupt Fail | |
| F303 | UART2 Receive Interrupt Fail | |
| F304 | UART2 Receive Err Int Fail | |
| F305 | UART2 Baud Rate Test 1 Fail | |
| F306 | UART2 Baud Rate Test 2 Fail | |
| F307 | UART2 Baud Rate Test 3 Fail | |
| F310 | UART2 Channel 0 Fail | |
| F311 | UART2 Channel 1 Fail | |
| F312 | UART2 Channel 2 Fail | |
| F313 | UART2 Channel 3 Fail | |
| F314 | UART2 Channel 4 Fail | |
| F315 | UART2 Channel 5 Fail | |
| F316 | UART2 Channel 6 Fail | |
| F317 | UART2 Channel 7 Fail | |

**Table 2-3: NM4 SERVICE LOG ERROR EVENTS**

| Touch Panel Events | | |
|---|---|---|
| Code | Description | Recommended Action |
| T001 | Bad Device Recalibration | Clear obstructions. If recurring, replace touch panel |
| **Head Assembly Events** | | |
| Code | Description | Recommended Action |
| H001 | Head Temperature Error | Call Tech. Service |
| A001 | Pattern Adjusted | None |
| **Power Supply Events** | | |
| Code | Description | Recommended Action |
| P001 | AC Fail | Restore AC power |
| P002 | AC Good | None |
| P003 | Battery Low | Recharge battery. If persistent, replace battery |
| P004 | Battery Good | None |
| P005 | Brick Bad | Replace Pwr Supply PCB |
| **MSPEC Events** | | |
| Code | Description | Recommended Action |
| M001 | Channel Err Active CPU | Replace MSPEC |
| M002 | Channel Err Inactive CPU | |
| M003 | Command Retry | |
| M004 | Comm Error | |
| M005 | System Fault Max | |
| M006 | Versiion ID Retry | |
| M007 | Span Fail | |
| M008 | Solenoid Stuck | |
| M009 | Zero Timeout | |
| M010 | Zero Fail Max | |

**Table 2-3 (continued): NM4 SERVICE LOG ERROR EVENTS**

| MSPEC Events (continued) | | |
|---|---|---|
| Code | Description | Recommended Action |
| M011 | RX Buffer Overflow | Replace MSPEC |
| M012 | No Continuous Data | Replace MSPEC |
| M013 | Line Block Diff | Clear Blockage |
| M014 | Line Block Less Than Min | Clear Blockage |
| M016 | Multispec Shutdown | Replace MSPEC |
| M101 | CD Chan Err | Call Tech. Service |
| M102 | Chan Err O2 Info P1 | |
| M103 | Chan Err O2 Info P2 | |
| Datagrip Events | | |
| DG00 | Datagrip Internal Error | Replace Datagrip |
| DG01 | Datagrip Internal Error | |
| DG02 | Datagrip Internal Error | |

**Table 2-3 (continued): NM4 SERVICE LOG ERROR EVENTS**

| NIBP Events | | |
|---|---|---|
| Code | Description | Recommended Action |
| N001 | NIBP Mon Error | Replace NIBP |
| N002 | NIBP Com Error | Replace NIBP |
| N003 | NIBP Bad Data | Call Tech. Service |
| N004 | Infl Pres Not GT 30 | Check for Leaks |
| N005 | Error Rcvd from NIBP | Replace NIBP |
| N006 | NIBP Mode Conflict | Replace NIBP |

**Table 2-4: NM4 SERVICE LOG SERVICE EVENT CODES**

| Code | Description |
|---|---|
| S001 | INST |
| S002 | PMS |
| S003 | SRVC |
| S004 | Secondary Serv Screen Entry |
| S005 | Reset Service Date |
| S006 | Service Log Clear |

**Table 2-5: NM4 SERVICE LOG CALIBRATION EVENT CODES**

| Code | Description | Code | Description |
|---|---|---|---|
| C001 | O2 Store Zero A | C009 | Respiratory Flow Store Span |
| C002 | O2 Store Zero B | C010 | Respiratory Flow Store Zero |
| C003 | Line Block Store Reference | C011 | Pressure Store Span |
| C004 | Gas Analyzer - Start | C012 | Pressure Store Zero |
| C005 | Gas Analyzer - Continue | C013 | NIBP Infl Check |
| C006 | NIBP Inflate | C014 | NIBP Defl Ck |
| C007 | NIBP Stop | C015 | NIBP Leak Ck |
| C008 | NIBP Take Reading | | |

**Table 2-6: NM4 O.R. DATA MANAGER EVENT CODES**

| Code | Description | Recommended Action |
|---|---|---|
| V001 | VTLK Com Error | Replace ORDM if recurring |
| V002 | VTLK Com Lost | |
| V003 | VTLK Com Regained | None |
| V010 | ORDM Startup Failure | Replace ORDM |
| V011 | ORDM Inact Startup Failure | |

**Table 2-7: NM4 TEMPLATE EVENT CODES**

| Code | Description | Recommended Action |
|---|---|---|
| TEM0 | Template Defaults Loaded | None |
| TEM1 | Recreating Tmplt Database | |
| TEM2 | Templates Reinitalized | |
| TEM3 | Templates Reinitalized | |
| TEM4 | Factory Defaults Installed | |

Touch the PRINT LOG key to obtain a Service Log Printout from the internal printer. Figure 2-5 shows the format of the printed service log.

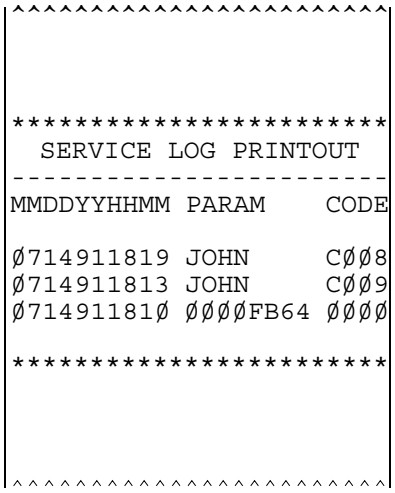



**Figure 2-5: SERVICE LOG PRINTOUT**

## 2.3 PMS Criteria Screen

Touch the PMS CRITERIA key to bring up the screen shown in Figure 2-6.

Touch the Month window, scroll to the next PMS due month with the Selection DIAL, and press the dial to enter the month in which the PREVENTIVE MAINTENANCE DUE message will appear on the power-up screen.

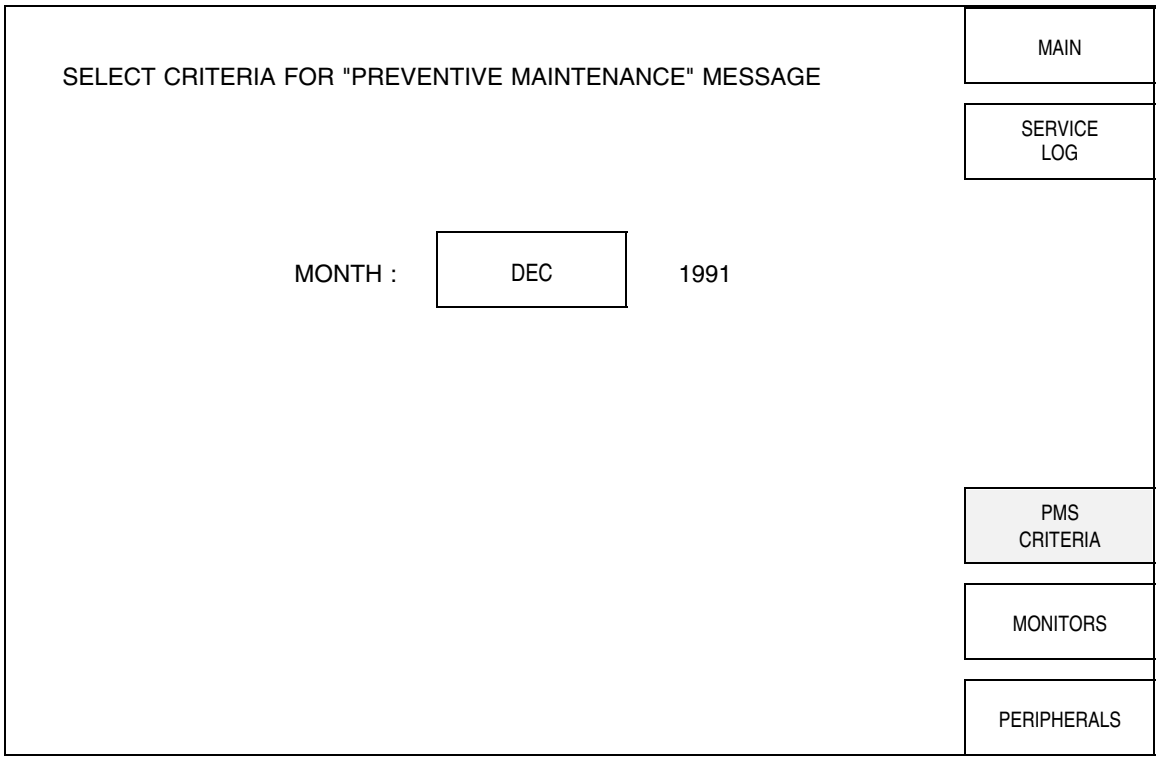



**Figure 2-6: PMS CRITERIA SCREEN**

## 2.4 Monitors

Touch the MONITORS key to bring up a second column of touch keys. These keys select the calibration screens for the system sensors.

### 2.4.1 Oxygen Monitor Screen

The Oxygen Monitor Screen displays current oxygen cell readings and provides a calibration procedure for the oxygen sensor circuitry. A touch key allows entry of a new zero value. See Figure 2-7.

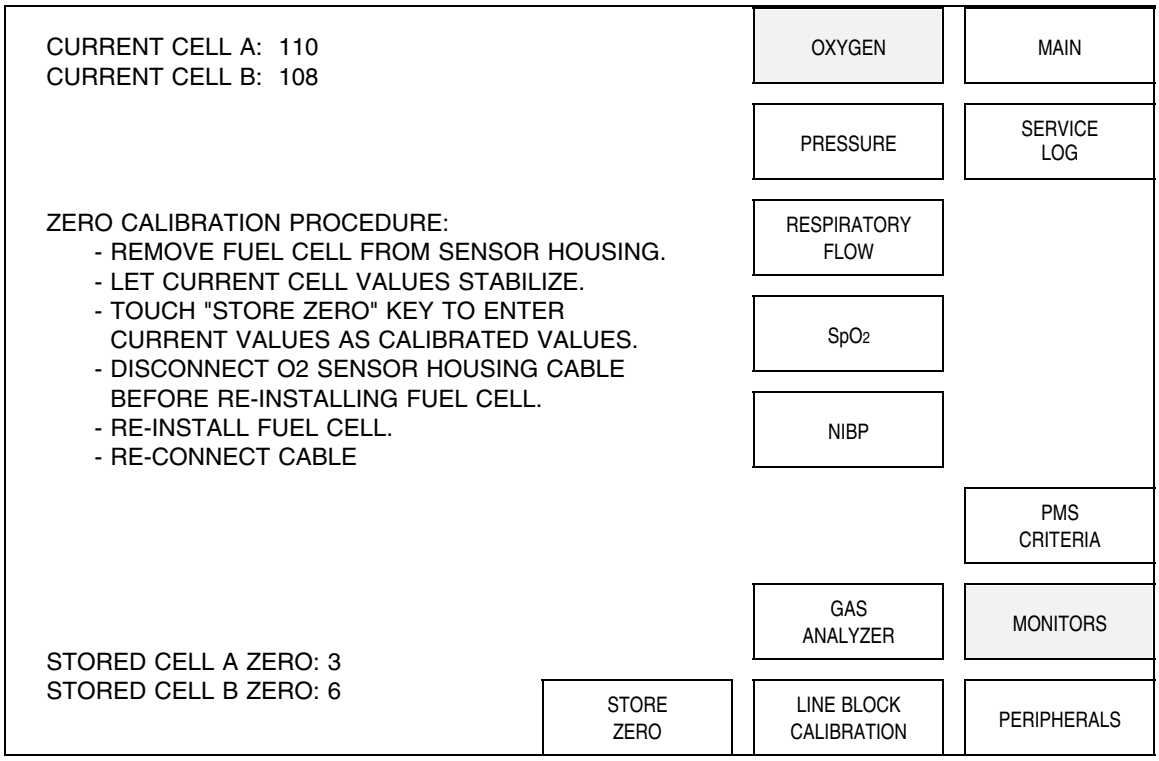



**Figure 2-7: OXYGEN MONITOR SCREEN**

### 2.4.2 Breathing Pressure Monitor Screen

The Breathing Pressure Monitor Screen displays current airway pressure and provides a calibration procedure for the pressure sensing circuitry. Touch keys allow entry of new zero and span settings. See Figure 2-8.

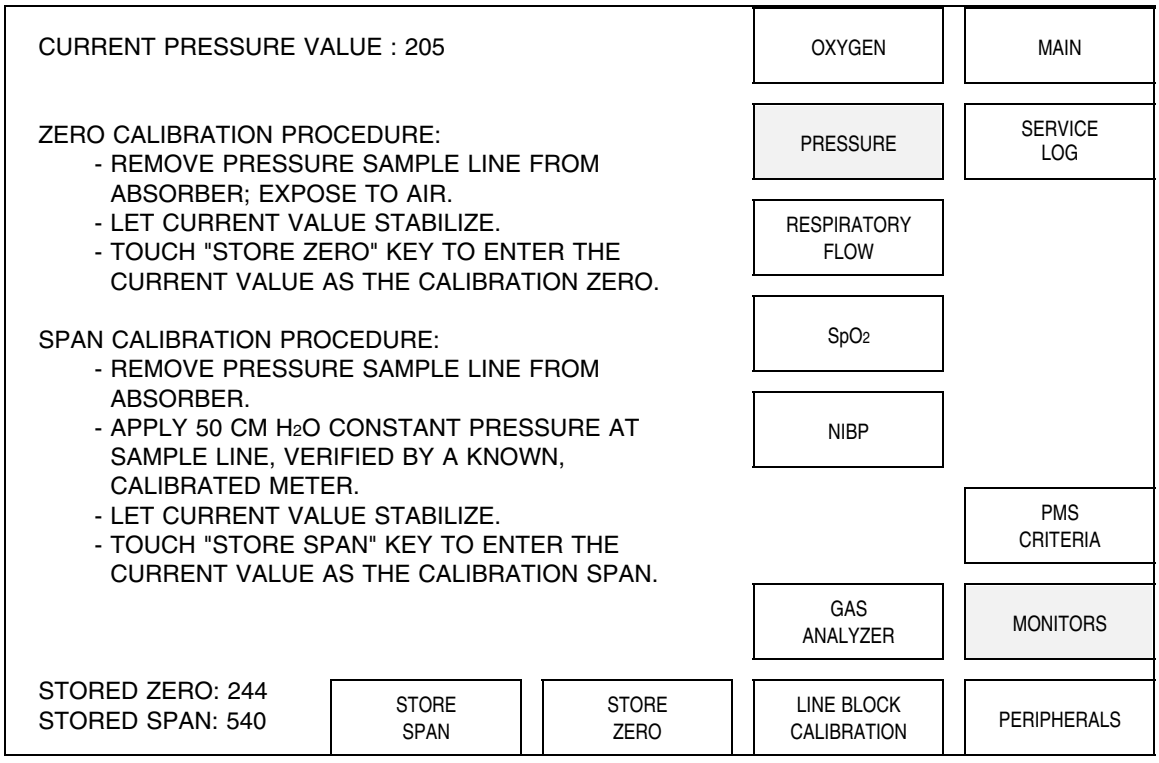

CURRENT PRESSURE VALUE : 205
ZERO CALIBRATION PROCEDURE:
- REMOVE PRESSURE SAMPLE LINE FROM ABSORBER; EXPOSE TO AIR.
- LET CURRENT VALUE STABILIZE.
- TOUCH "STORE ZERO" KEY TO ENTER THE CURRENT VALUE AS THE CALIBRATION ZERO.
SPAN CALIBRATION PROCEDURE:
- REMOVE PRESSURE SAMPLE LINE FROM ABSORBER.
- APPLY 50 CM H2O CONSTANT PRESSURE AT SAMPLE LINE, VERIFIED BY A KNOWN, CALIBRATED METER.
- LET CURRENT VALUE STABILIZE.
- TOUCH "STORE SPAN" KEY TO ENTER THE CURRENT VALUE AS THE CALIBRATION SPAN.
STORED ZERO: 244
STORED SPAN: 540
OXYGEN
MAIN
PRESSURE
SERVICE LOG
RESPIRATORY FLOW
SpO2
NIBP
PMS CRITERIA
GAS ANALYZER
MONITORS
STORE SPAN
STORE ZERO
LINE BLOCK CALIBRATION
PERIPHERALS

**Figure 2-8: BREATHING PRESSURE MONITOR SCREEN**

### 2.4.3 Respiratory Flow Monitor Screen

The Respiratory Flow Monitor Screen displays the current flow reading and also shows a calibration procedure for the flow sensing circuitry. Touch keys are provided for entry of new zero and span settings. See Figure 2-9.

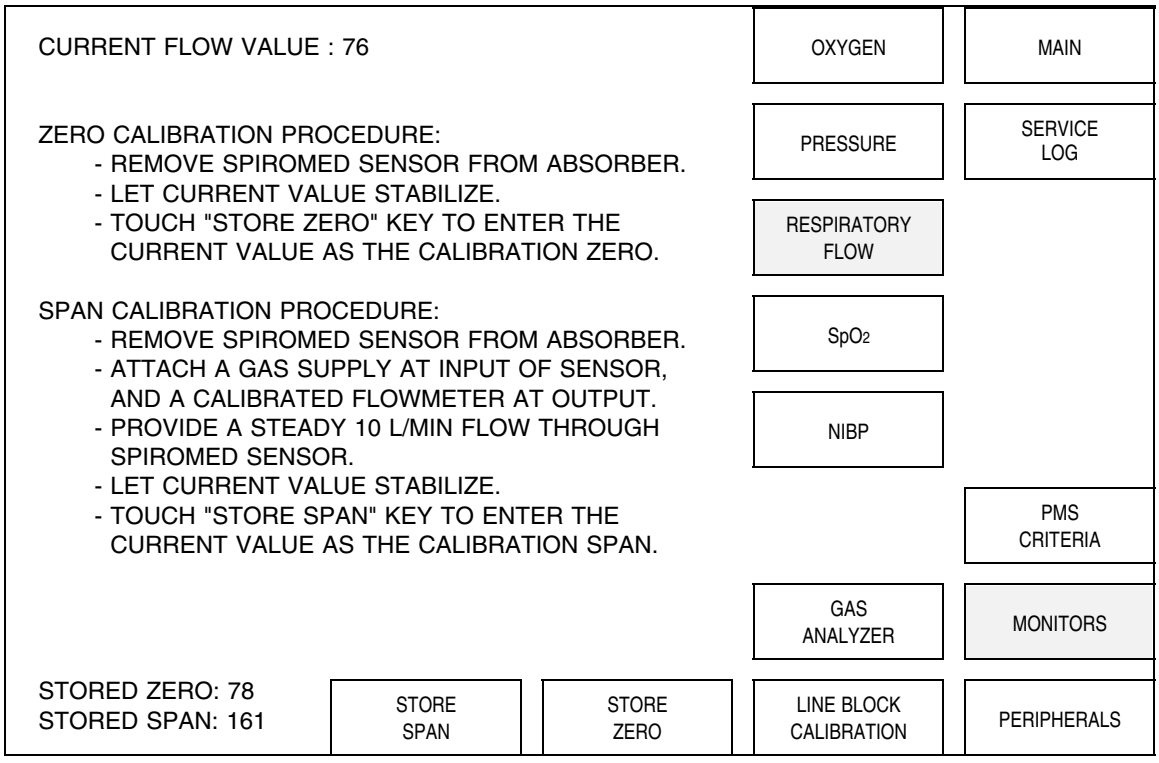

CURRENT FLOW VALUE : 76
ZERO CALIBRATION PROCEDURE:
- REMOVE SPIROMED SENSOR FROM ABSORBER.
- LET CURRENT VALUE STABILIZE.
- TOUCH "STORE ZERO" KEY TO ENTER THE CURRENT VALUE AS THE CALIBRATION ZERO.
SPAN CALIBRATION PROCEDURE:
- REMOVE SPIROMED SENSOR FROM ABSORBER.
- ATTACH A GAS SUPPLY AT INPUT OF SENSOR, AND A CALIBRATED FLOWMETER AT OUTPUT.
- PROVIDE A STEADY 10 L/MIN FLOW THROUGH SPIROMED SENSOR.
- LET CURRENT VALUE STABILIZE.
- TOUCH "STORE SPAN" KEY TO ENTER THE CURRENT VALUE AS THE CALIBRATION SPAN.
STORED ZERO: 78
STORED SPAN: 161
STORE SPAN
STORE ZERO
OXYGEN
PRESSURE
RESPIRATORY FLOW
SpO2
NIBP
GAS ANALYZER
LINE BLOCK CALIBRATION
MAIN
SERVICE LOG
PMS CRITERIA
MONITORS
PERIPHERALS

**Figure 2-9: RESPIRATORY FLOW MONITOR SCREEN**

### 2.4.4 SpO2 Monitor Screen

The $SpO_2$ Screen displays current values for $SpO_2$, Pulse, $SpO_2$ Pleth and $SpO_2$ Bargraph. See Figure 2-10.

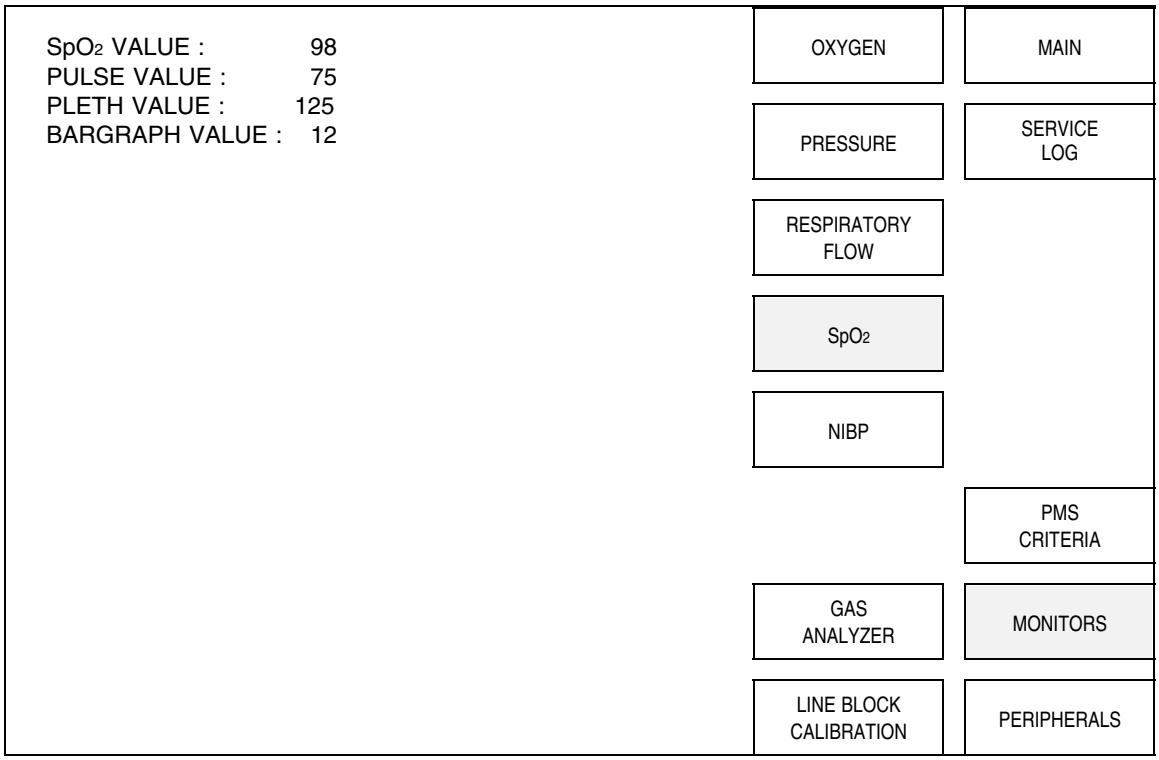



**Figure 2-10: $SpO_2$ MONITOR SCREEN**

### 2.4.5 NIBP Monitor Screen

The NIBP Monitor Screen displays Real Time, Systolic, Diastolic and Mean blood pressure and Pulse.

The TAKE READING touch key will initiate a single NIBP measurement cycle.

A procedure for checking NIBP cuff inflation pressure against an external gauge is also displayed, with touch keys to perform the test. See Figure 2-11.

Refer to Section 6 of this manual for inflation, deflation, and leak testing procedures.

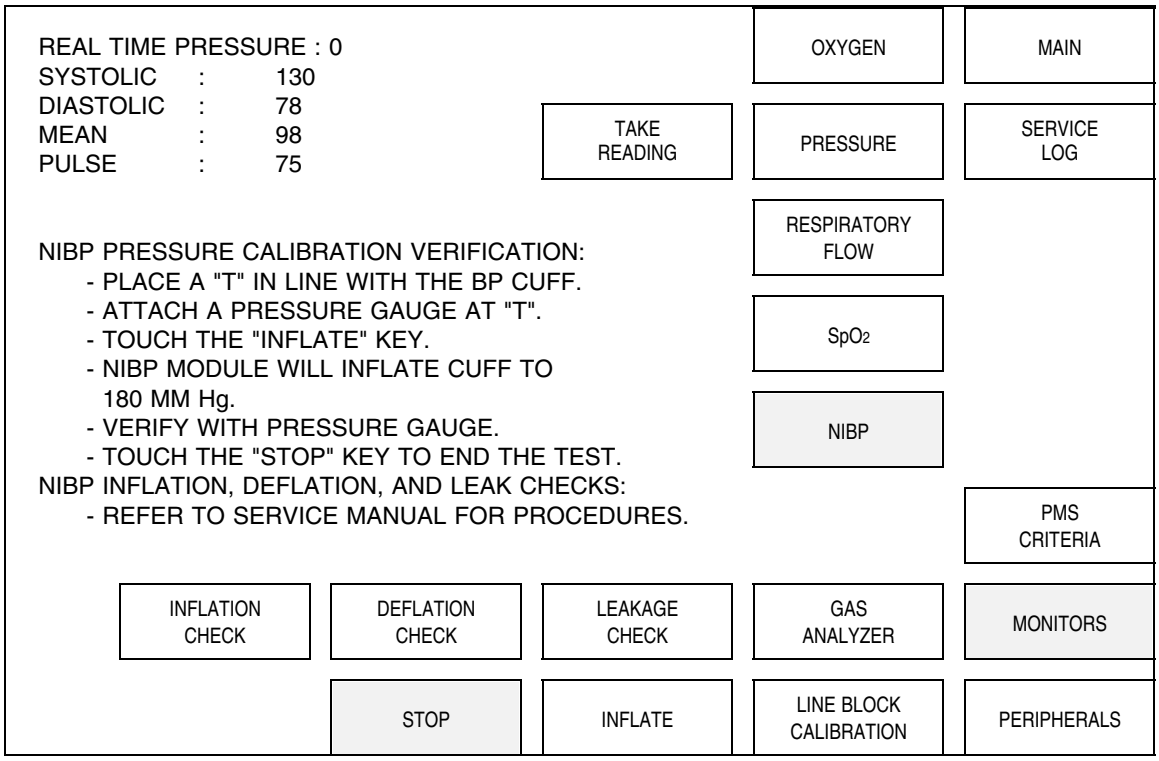



**Figure 2-11: NIBP MONITOR SCREEN**

### 2.4.6 Gas Analyzer Screen

Current values of $CO_2$, $N_2O$ and anesthetic agent are displayed on the Gas Analyzer Screen along with a span calibration procedure. See Figure 2-12. (The scrubber bottle replacement instruction is not displayed on machines having a Model 4610 gas analyzer.)

The MODE window on the gas analyzer screen displays the following messages:
- INHIBIT during warm-up
- READY after 30 minute warm-up

The STATUS window on the gas analyzer screen displays the following messages:
- IDLE before starting calibration
- ZERO IN PROGRESS during calibration
- ZERO COMPLETE during calibration
- SPAN IN PROGRESS during calibration
- PASSED or FAILED after calibration

The complete calibration procedure is outlined in Section 5.

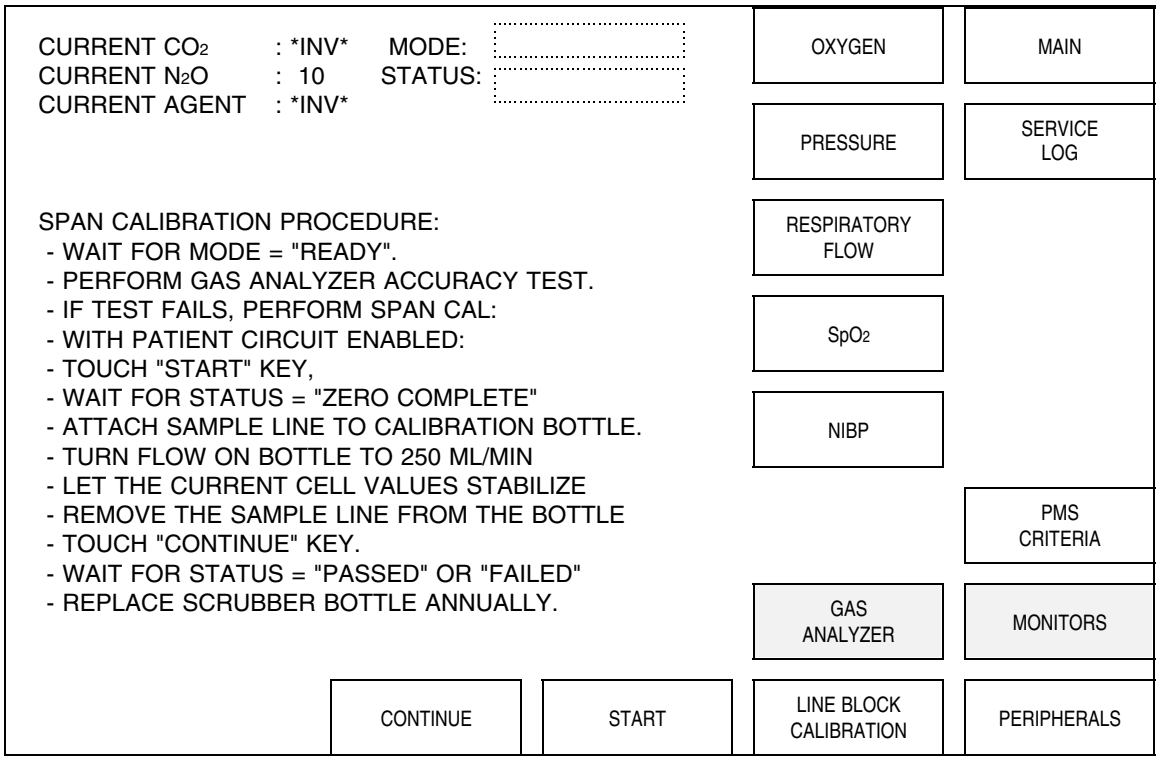



**Figure 2-12: GAS ANALYZER SCREEN**

### 2.4.7 Line Block Screen

The current sample pressure is displayed on the Line Block screen along with a calibration procedure and a touch key to enter a setpoint value. See Figure 2-13. The stored reference value is displayed at the lower left corner of the screen.

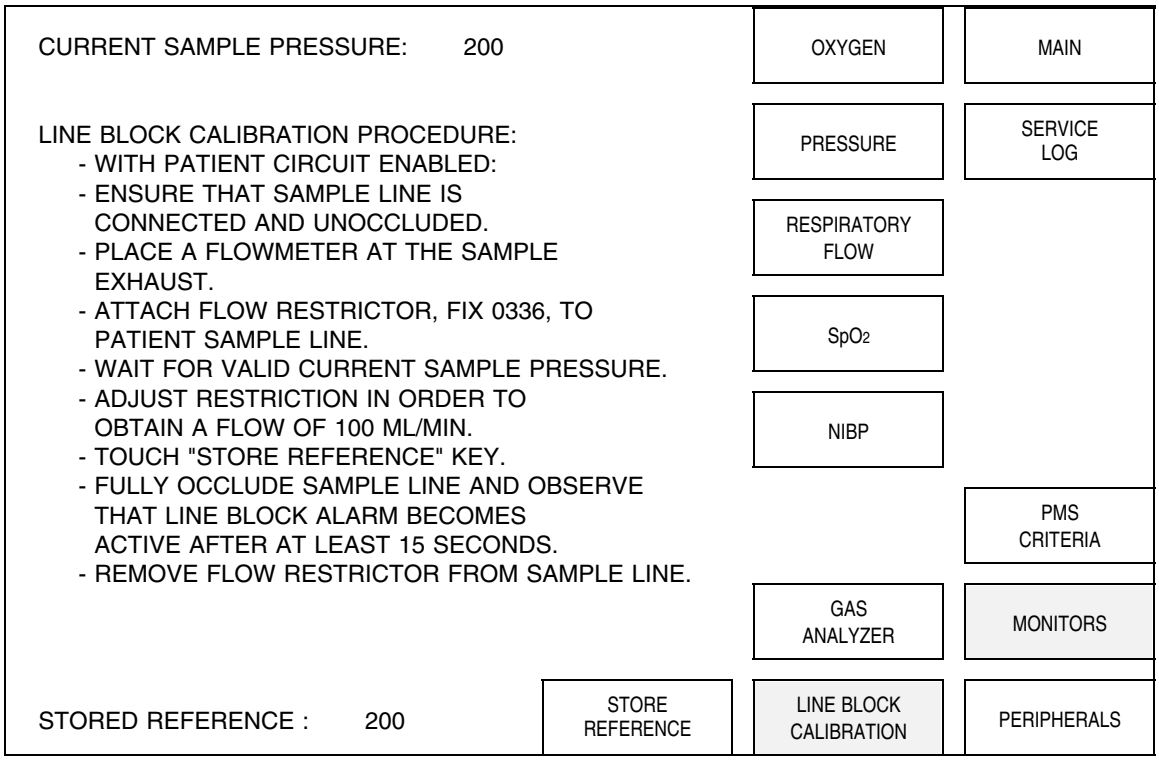

CURRENT SAMPLE PRESSURE: 200
LINE BLOCK CALIBRATION PROCEDURE:
- WITH PATIENT CIRCUIT ENABLED:
- ENSURE THAT SAMPLE LINE IS CONNECTED AND UNOCCLUDED.
- PLACE A FLOWMETER AT THE SAMPLE EXHAUST.
- ATTACH FLOW RESTRICTOR, FIX 0336, TO PATIENT SAMPLE LINE.
- WAIT FOR VALID CURRENT SAMPLE PRESSURE.
- ADJUST RESTRICTION IN ORDER TO OBTAIN A FLOW OF 100 ML/MIN.
- TOUCH "STORE REFERENCE" KEY.
- FULLY OCCLUDE SAMPLE LINE AND OBSERVE THAT LINE BLOCK ALARM BECOMES ACTIVE AFTER AT LEAST 15 SECONDS.
- REMOVE FLOW RESTRICTOR FROM SAMPLE LINE.
STORED REFERENCE : 200
STORE REFERENCE
OXYGEN
PRESSURE
RESPIRATORY FLOW
SpO2
NIBP
GAS ANALYZER
LINE BLOCK CALIBRATION
MAIN
SERVICE LOG
PMS CRITERIA
MONITORS
PERIPHERALS

**Figure 2-13: LINE BLOCK CALIBRATION SCREEN**

## 2.5 Peripherals

Touching the PERIPHERALS key brings up a second column of touch keys that are used to select additional service screen functions. When PERIPHERALS is selected, the Relays Status And Control Screen will appear as shown in Figure 2-14.

### 2.5.1 Relays Status And Control Screen

Printer Relay:

When the ORDM key is selected, the external printer port is connected to the O.R. DATA MANAGER. See Paragraph 2.8

Remote Panel Relay:

When the ORDM key is selected, the Remote Display will show the O.R. DATA MANAGER functions. See Paragraph 2.6. When the NM4 key is selected, the Remote Display shows the NM4 data and alarms.

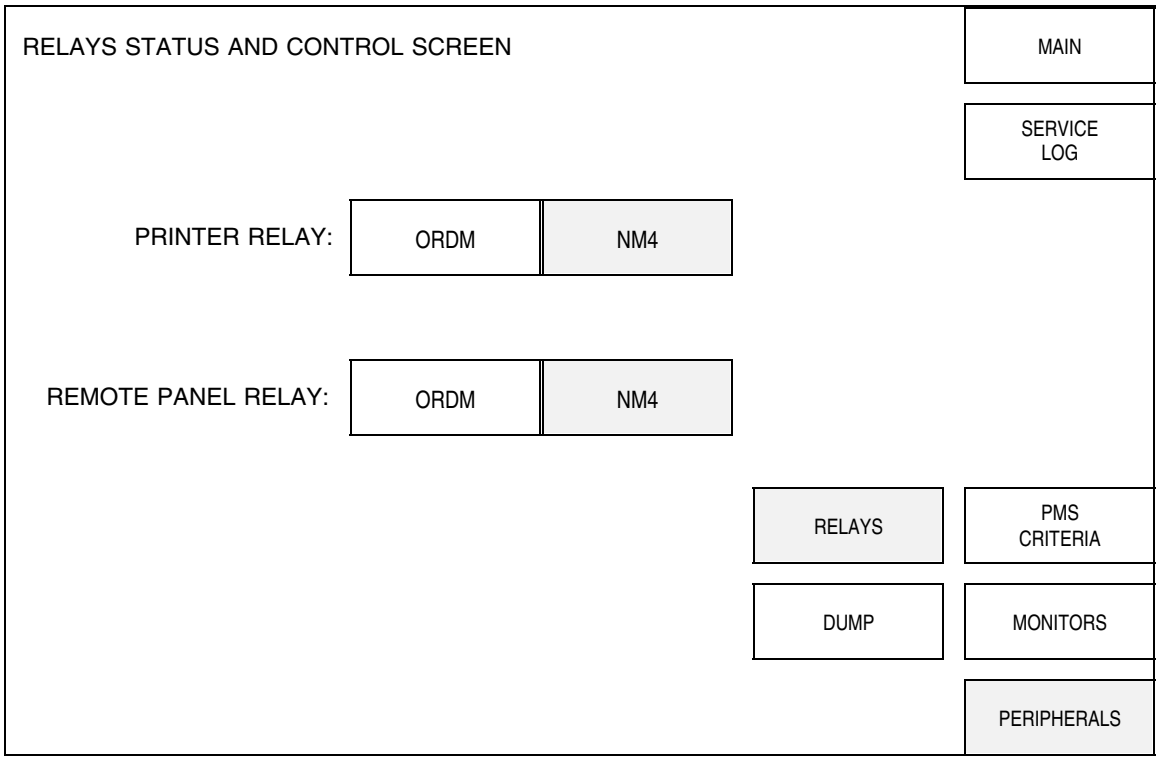



**Figure 2-14: RELAYS STATUS AND CONTROL SCREEN**

### 2.5.2 Service Dump Screen

The DUMP key will bring up the Service Dump Screen shown in Figure 2-15. This screen displays processor address and register debug information. This screen should be checked whenever the machine is serviced, and any non-zero codes that appear should be recorded and reported to the N.A.D. Engineering Department.

Touch the PRINT DUMP key to print out the codes on the strip chart recorder. Figure 2-16 shows the printed format of the Service Dump.

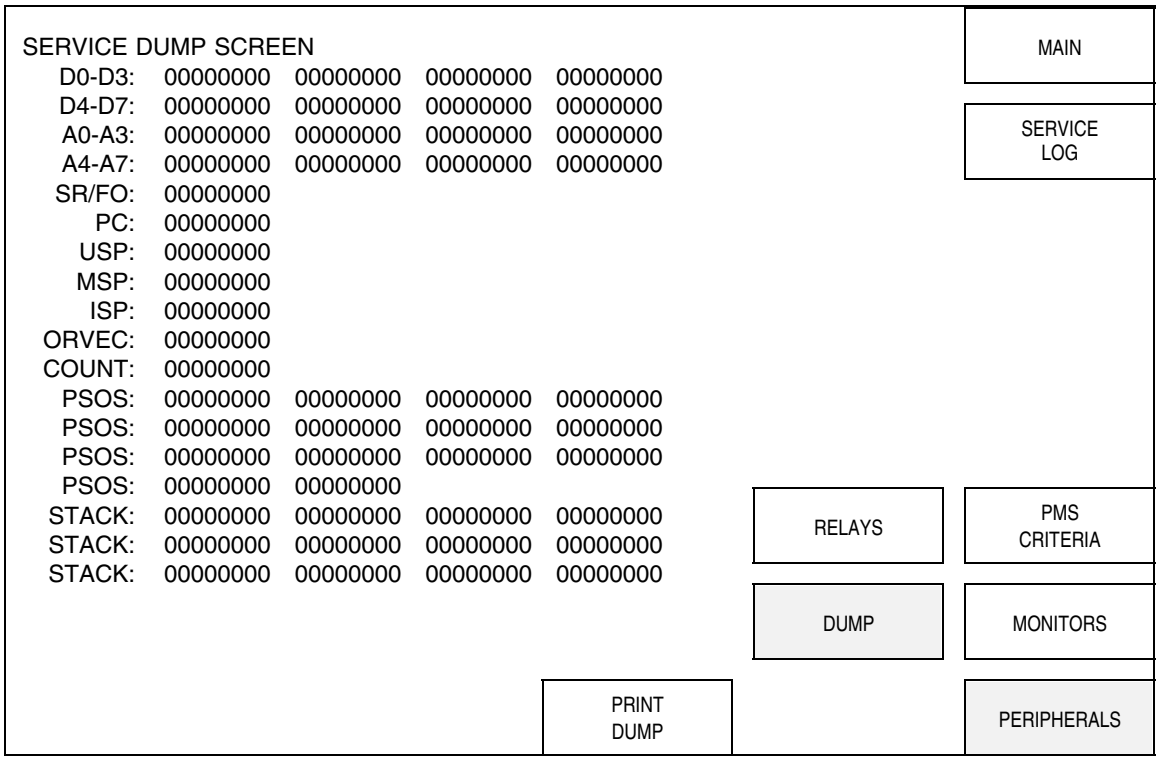



**Figure 2-15: SERVICE DUMP SCREEN**

```
^^^^^^^^^^^^^^^^^^^^^^^^^^


**********************
      SERVICE DUMP
----------------------

DØ-D1: ØØØØØØØØ ØØØØØØØØ
D2-D3: ØØØØØØØØ ØØØØØØØØ
D4-D5: ØØØØØØØØ ØØØØØØØØ
D6-D7: ØØØØØØØØ ØØØØØØØØ
AØ-A1: ØØØØØØØØ ØØØØØØØØ
A2-A3: ØØØØØØØØ ØØØØØØØØ
A4-A5: ØØØØØØØØ ØØØØØØØØ
A6-A7: ØØØØØØØØ ØØØØØØØØ
SR/FO: ØØØØØØØØ
   PC: ØØØØØØØØ
  USP: ØØØØØØØØ
  MSP: ØØØØØØØØ
  ISP: ØØØØØØØØ
ORVEC: ØØØØØØØØ
COUNT: ØØØØØØØØ
 PSOS: ØØØØØØØØ ØØØØØØØØ
 PSOS: ØØØØØØØØ ØØØØØØØØ
 PSOS: ØØØØØØØØ ØØØØØØØØ
 PSOS: ØØØØØØØØ ØØØØØØØØ
 PSOS: ØØØØØØØØ ØØØØØØØØ
 PSOS: ØØØØØØØØ ØØØØØØØØ
 PSOS: ØØØØØØØØ ØØØØØØØØ
STACK: ØØØØØØØØ ØØØØØØØØ
STACK: ØØØØØØØØ ØØØØØØØØ
STACK: ØØØØØØØØ ØØØØØØØØ
STACK: ØØØØØØØØ ØØØØØØØØ
STACK: ØØØØØØØØ ØØØØØØØØ
STACK: ØØØØØØØØ ØØØØØØØØ



^^^^^^^^^^^^^^^^^^^^^^^^^^
```

**Figure 2-16: SERVICE DUMP PRINTOUT**

## 2.6 O.R. DATA MANAGER Diagnostics

During Power Up/Initialization and following completion of the NM4 boot sequence, the O.R. DATA MANAGER performs diagnostic tests on its CPU. Figures 2-17A and 2-17B show the O.R. DATA MANAGER boot information that appears on the Remote Display.

Error messages may appear in the display at this time. If the keyboard is not connected at power-up, a keyboard error message appears as shown in the illustration. System configuration or set-up errors may also appear in the area shown in the illustration. If an error message is displayed, the screen display will freeze with a choice of options at the bottom of the screen. The Troubleshooting Guides in Section 3 provide additional information that correlates error messages to recommended hardware replacement.

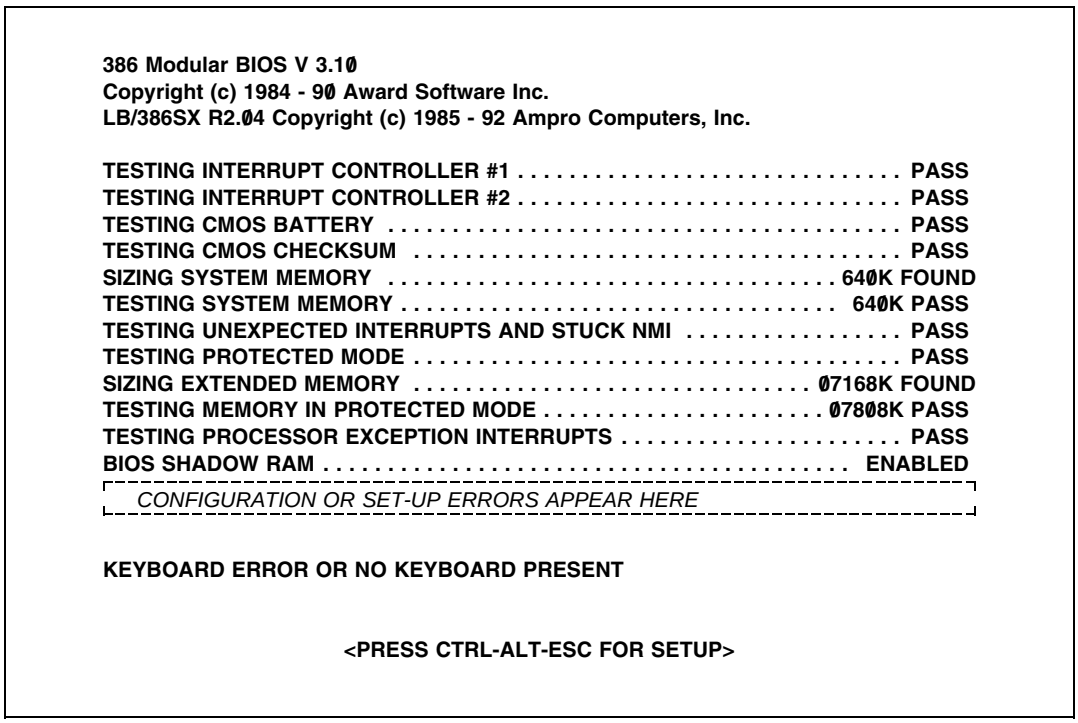

386 Modular BIOS V 3.10
Copyright (c) 1984 - 90 Award Software Inc.
LB/386SX R2.04 Copyright (c) 1985 - 92 Ampro Computers, Inc.
TESTING INTERRUPT CONTROLLER #1 . . . . . PASS
TESTING INTERRUPT CONTROLLER #2 . . . . . PASS
TESTING CMOS BATTERY . . . . . PASS
TESTING CMOS CHECKSUM . . . . . PASS
SIZING SYSTEM MEMORY . . . . . 640K FOUND
TESTING SYSTEM MEMORY . . . . . 640K PASS
TESTING UNEXPECTED INTERRUPTS AND STUCK NMI . . . . . PASS
TESTING PROTECTED MODE . . . . . PASS
SIZING EXTENDED MEMORY . . . . . 07168K FOUND
TESTING MEMORY IN PROTECTED MODE . . . . . 07808K PASS
TESTING PROCESSOR EXCEPTION INTERRUPTS . . . . . PASS
BIOS SHADOW RAM . . . . . ENABLED
CONFIGURATION OR SET-UP ERRORS APPEAR HERE
KEYBOARD ERROR OR NO KEYBOARD PRESENT
<PRESS CTRL-ALT-ESC FOR SETUP>

**Figure 2-17A: O.R. DATA MANAGER POWER-UP DIAGNOSTICS SCREEN**

```
Press ESC to abort Hard disk boot
Booting Hard Drive
Loading...
EMM 386 V1.21 /Frame = C000 /Kb = 7168 /Bdos = FFFF

DR DOS Release 5.0
Copyright (c) 1976, 1982, 1988, 1990 Digital Research Inc. All rights reserved.
Ampro Computers, Inc.

Executing runtime.bat on the hard drive.
Executing numoff.com.
Checking the CRC on ordm386.EXE with the CRC saved in the file CRC_ordm.

CRC calculation taking place.
```

**Figure 2-17B: O.R. DATA MANAGER DIAGNOSTICS - SECOND SCREEN**

## 2.7 O.R. DATA MANAGER Software Version Window

After power-up and when the O.R. DATA MANAGER is in its normal display mode, the software version can be displayed by pressing the ALT and V keys simultaneously. The window shown in Figure 2-18 will appear at the center of the display for approximately three seconds. The message in parenthesis (xxxxH) is an identifier that is unique to the particular software installation.

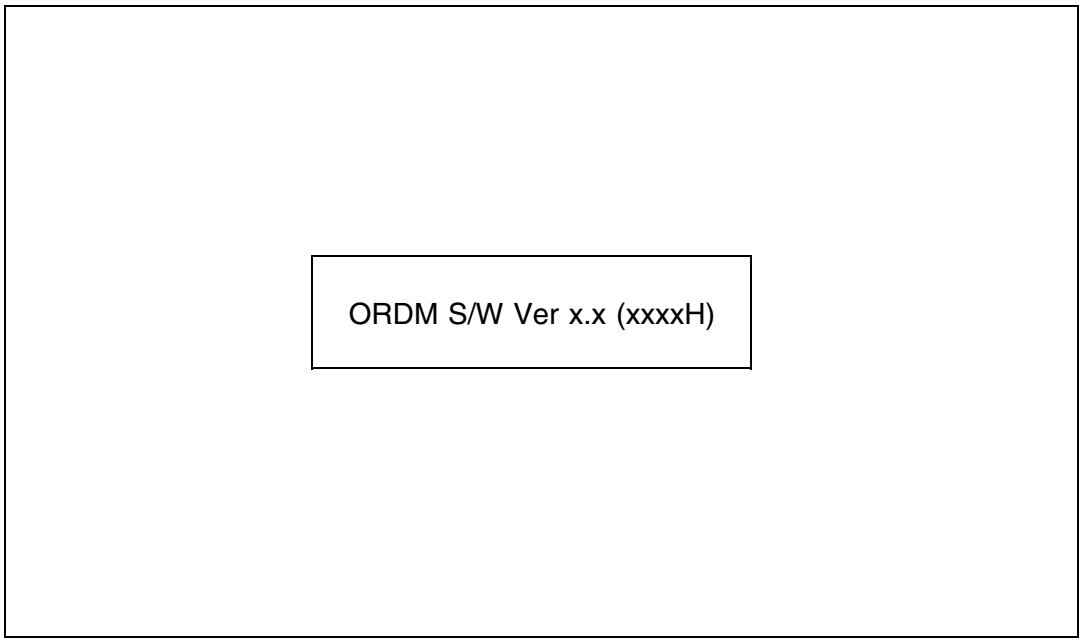



**Figure 2-18: SOFTWARE VERSION WINDOW**

## 2.8 Printer Configuration

The O.R. DATA MANAGER is configured to operate with the Hewlett Packard LaserJet IIP Printer or the Hewlett Packard LaserJet IIIP Printer in the serial port configuration. The following paragraphs describe how to run a printer self-test, and illustrate the configuration menus that appear on the self-test printout page.

### 2.8.1 Hewlett Packard LaserJet IIP Printer Self-Test:

If the printer ON LINE indicator light is on, press the ON LINE key to take the printer off-line.

While holding the down the ALT key, press the TEST key. The printer display window will show 05 SELF TEST.

A few seconds later, 06 PRINT TEST will appear in the display window. Two pages will print: the self-test printout page and a "cleaning" page.

The self-test printout page lists the settings for both the printer menu and the configuration menu. The list should read as follows:

```
PRINTING MENU
  COPIES     1
  FONT SRC   I (Internal)
  FONT NUM   0
  TRAYS      LC ONLY
  JOB SIZE   LETTER
  ORIENT     P (Portrait)
  LINES OF   TXT  60
  MAN FEED   OFF
  SYM SET    ROMAN-8
CONFIGURATION MENU:
  AUTOCONT   ON
  I/O        SERIAL
  BAUDRATE   9600
  ROBUST     XON ON
  DTRPOLAR   HI

RAM size:  1536K bytes
Firmware Datecode:  19890523
Internal Font Datecode:  19890213
Font Cartridges Installed:  NO
Installed options:  LC TRAY (LETTER)
```

If the self test printout differs from that shown in the illustration (with the exception of Firmware Datecode and Internal Font Datecode), the printer's internal setup must be changed. Refer to the instructions in the ***H-P LaserJet IIP Printer User's Manual, Chapters 3 and 4,*** supplied with the printer, for making any changes.

### 2.8.2 Hewlett Packard LaserJet IIIP Printer Self-Test:

If the printer ON LINE indicator light is on, press the ON LINE key to take the printer off-line.

While holding the down the ALT key, press the TEST key. The printer display window will show 05 SELF TEST.

A few seconds later, 06 PRINT TEST will appear in the display window. Two pages will print: the self-test printout page and a "cleaning" page.

The self-test printout page lists the settings for both the printer menu and the configuration menu. The list should read as follows:

```
    PRINTING MENU:
  MP SIZE   LETTER
     COPIES    1
     FONT SRC  I (Internal)
     FONT NUM  0
     TRAYS     LC ONLY
     JOB SIZE  LETTER
     ORIENT    P (Portrait)
     LINES OF  TXT  60
     MAN FEED  OFF
     SYM SET   ROMAN-8
    CONFIGURATION MENU:
     AUTOCONT  ON
     I/O       SERIAL
     BAUDRATE  9600
     ROBUST    XON ON
     DTRPOLAR  HI
  RET       MEDIUM

    RAM size:  1024K bytes
Page Count:  6574
    Firmware Datecode:  19910523
    Internal Font Datecode:  19910213
    Font Cartridges Installed:  NO
    Installed options:  LC TRAY (LETTER)
```

If the self test printout differs from that shown in the illustration (with the exception of Page Count, Firmware Datecode and Internal Font Datecode), the printer's internal setup must be changed. Refer to the instructions in the ***H-P LaserJet IIIP Printer User's Manual, Chapters 2 - 4,*** supplied with the printer, for making any changes.

RETURN TO THIS MANUAL'S TABLE OF CONTENTS
RETURN TO CD-ROM TABLE OF CONTENTS

# 3.0 TROUBLESHOOTING

This section contains information to assist the Draeger Medical, Inc. qualified Technical Service Representative (TSR) in locating electrical faults affecting the NARKOMED 4 monitoring and display devices. Since most troubleshooting efforts begin with verifying power supply voltages, the following paragraphs outline the voltage distribution scheme on the backplane along with power supply and test connector pin identification.

Also contained in this section are troubleshooting guide flow charts that provide a method of tracing faults to specific field replaceable assemblies or sub-assemblies in response to observed failure modes or symptoms.

## 3.1 Power Supply and Voltage Distribution

3.1.1 In the NARKOMED 4, voltages are distributed to the processor boards and peripheral devices from the backplane assembly. The TSR should start the troubleshooting procedure with voltage checks at the backplane. The wire harnesses originating at the power supply circuit board are connected to J28, J29, and J30 on the backplane.

3.1.2 These voltages can also be measured at test connector J15 on later model backplane assemblies. The acceptable voltage levels are listed in Table 3-1. Figure 3-1 shows the location of these connectors on the backplane. Refer to the replacement procedures in Section 4 for instructions on access to the backplane assembly. Be sure to observe all cautions that are listed.

3.1.3 If all the voltages are present, then ensure that all interconnecting ribbon cables and wire harnesses between suspected assemblies are properly seated. If all cables are properly seated, then proceed to the troubleshooting guides.

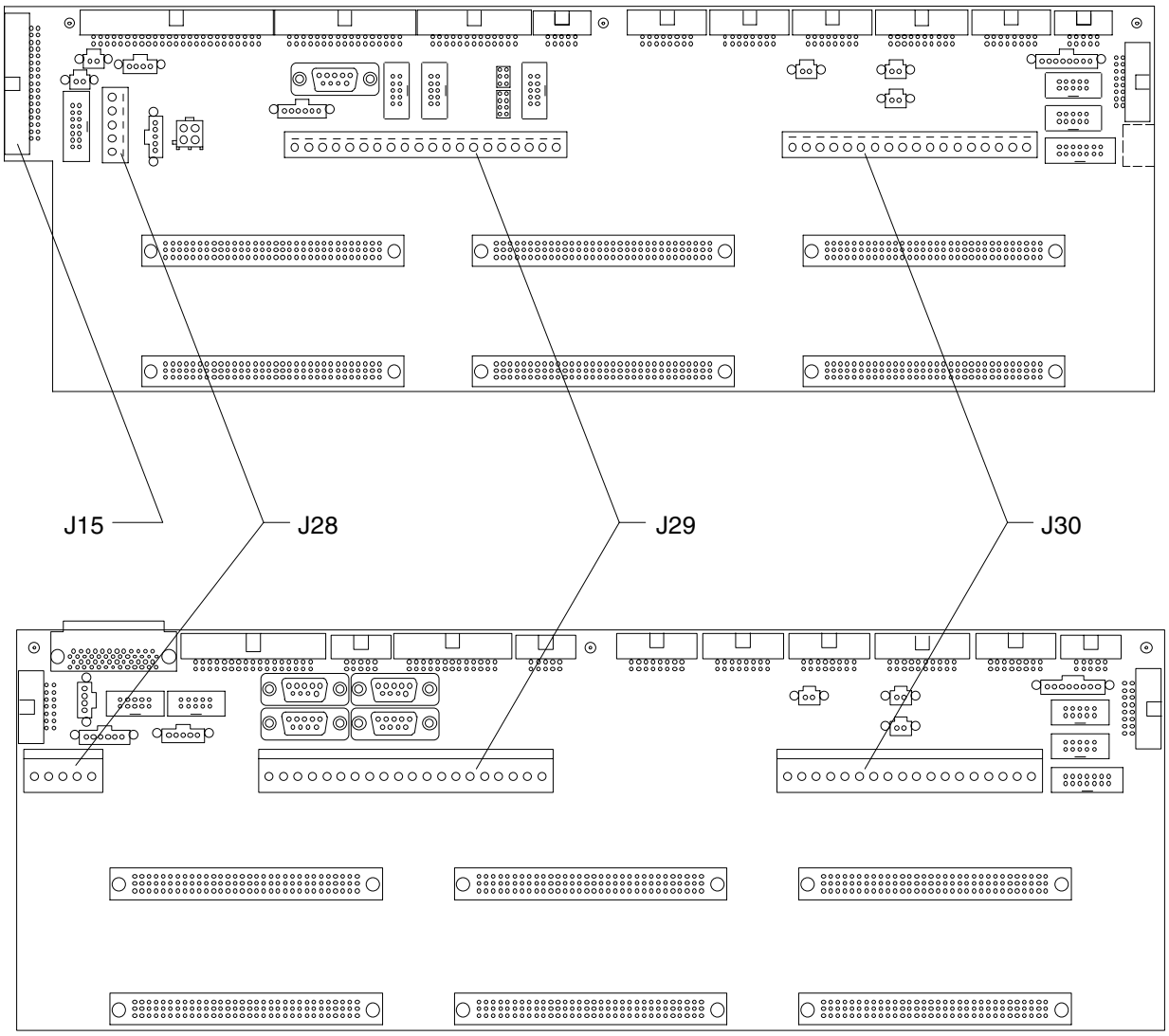
3.1.4 If any voltage is missing from backplane connectors J28, J29 or J30, proceed to the power supply voltage measurements in Paragraph 3.1.5.

**TABLE 3-1: BACKPLANE VOLTAGES**

| LOCATION | | VOLTAGE | ACCEPTABLE RANGE |
|---|---|---|---|
| TEST CONNECTOR | POWER SUPPLY CONNECTORS | | |
| J15-30 | J28-1 | +5SaO2 | 4.85 to 5.15 VDC |
| J15-32 | J28-4 | +15SaO2 | 14.25 to 15.75 VDC |
| J15-33 | J28-5 | -15SaO2 | -14.25 to -15.75 VDC |
| J15-31 | J28-2,3 | COMMON | |
| J15-17 | J29-1,2 | +12CRTA | 11.40 to 12.60 VDC |
| J15-12 | J29-5,6,7 | +5VMAIN | 4.85 to 5.15 VDC |
| J15-18 | J29-10,11 | +12CRTB | 11.40 to 12.60 VDC |
| J15-23 | J29-16 | +5VNIBP | 4.85 to 5.15 VDC |
| J15-24 | J29-17 | 0 ** | |
| J15-25 | J29-18 | +5VNIBP * | 4.85 to 5.15 VDC |
| J15-27 | J29-20 | +12VPUMP | 11.40 to 12.60 VDC |
| J15-10 | J29-12,13 | COMMON | |
| J15-13 | J30-1,2 | +5VBKUP | 4.85 to 5.15 VDC |
| J15-20 | J30-5,6 | +12VPP | 11.40 to 12.60 VDC |
| J15-14 | J30-9,10 | +5VXTRA | 4.85 to 5.15 VDC |
| J15-19 | J30-13,14 | +12CRTC | 11.40 to 12.60 VDC |
| J15-21 | J30-3,12 | COMMON | |

* Was -12 V on machines with early NIBP assembly.
** Was +12 V on machines with early NIBP assembly.

NARKOMED 4 BACKPLANE CIRCUIT BOARD ASSEMBLY




SV49031

NARKOMED 4 BACKPLANE CIRCUIT BOARD ASSEMBLY (EARLY MODELS)

**Figure 3-1: BACKPLANE CONNECTORS FOR POWER SUPPLY CABLES**

3.1.5 The red lamps on the power supply circuit board assembly provide diagnostic information on the status of the power supply. Figure 3-2 shows the location of these lamps. Refer to the replacement procedures in Section 4 for instructions on access to the power supply circuit board.

The red LED (DS2) will be lighted if any of the power supply voltages are out of tolerance. This lamp will also be lighted if the levels of the two backup batteries differ by more than 1.1 volt. The red LED (DS4) will be lighted during the power up self-test period, and will be off after the self-test is completed. This lamp will remain lighted if there is a power up self-test failure of the monitoring and communication circuitry on the power supply board.

The DC-DC converters supplying the 5V bus are protected by replaceable fuses F1 and F2, and the DC-DC converters supplying the 12V bus are protected by replaceable fuses F3, F4, and F5. Figure 3-2 shows the location of these fuses on the power supply circuit board.

Measure the voltages at connectors J1, J2 and J5 of the Power Supply Circuit Board assembly. The acceptable voltage levels are listed in Table 3-2. Figure 3-2 shows the location of these connectors on the circuit board.

**TABLE 3-2: POWER SUPPLY VOLTAGES**

| LOCATION | VOLTAGE | ACCEPTABLE RANGE |
|---|---|---|
| J1 - 1,2 | +5VBKUP | 4.85 to 5.15 VDC |
| J1 - 5,6 | +12VPP | 11.40 to 12.60 VDC |
| J1 - 9,10 | +5VXTRA | 4.85 to 5.15 VDC |
| J1 - 13,14 | +12CRTC | 11.40 to 12.60 VDC |
| J1 - 17,18 | +12VMGM | 11.40 to 12.60 VDC |
| J1 - 3,4,7,8 | COMMON | |
| J2 - 1,2 | +12CRTA | 11.40 to 12.60 VDC |
| J2 - 5,6,7 | +5VMAIN | 4.85 to 5.15 VDC |
| J2 - 10,11 | +12CRTB | 11.40 to 12.60 VDC |
| J2 - 16 | +5VNIBP | 4.85 to 5.15 VDC |
| J2 - 17 | +12VNIBP | 11.40 to 12.60 VDC |
| *J2 - 18 | -12VNIBP | -11.40 to -12.60 VDC |
| J2 - 20 | +12VPUMP | 11.40 to 12.60 VDC |
| J2 - 3,4,8,9 | COMMON | |
| J5 - 1 | +5SaO2 | 4.85 to 5.15 VDC |
| J5 - 4 | +15SaO2 | 14.25 to 15.75 VDC |
| J5 - 5 | -15SaO2 | -14.25 to -15.75 VDC |
| J5 - 2,3 | COMMON | |

* Not used in later design

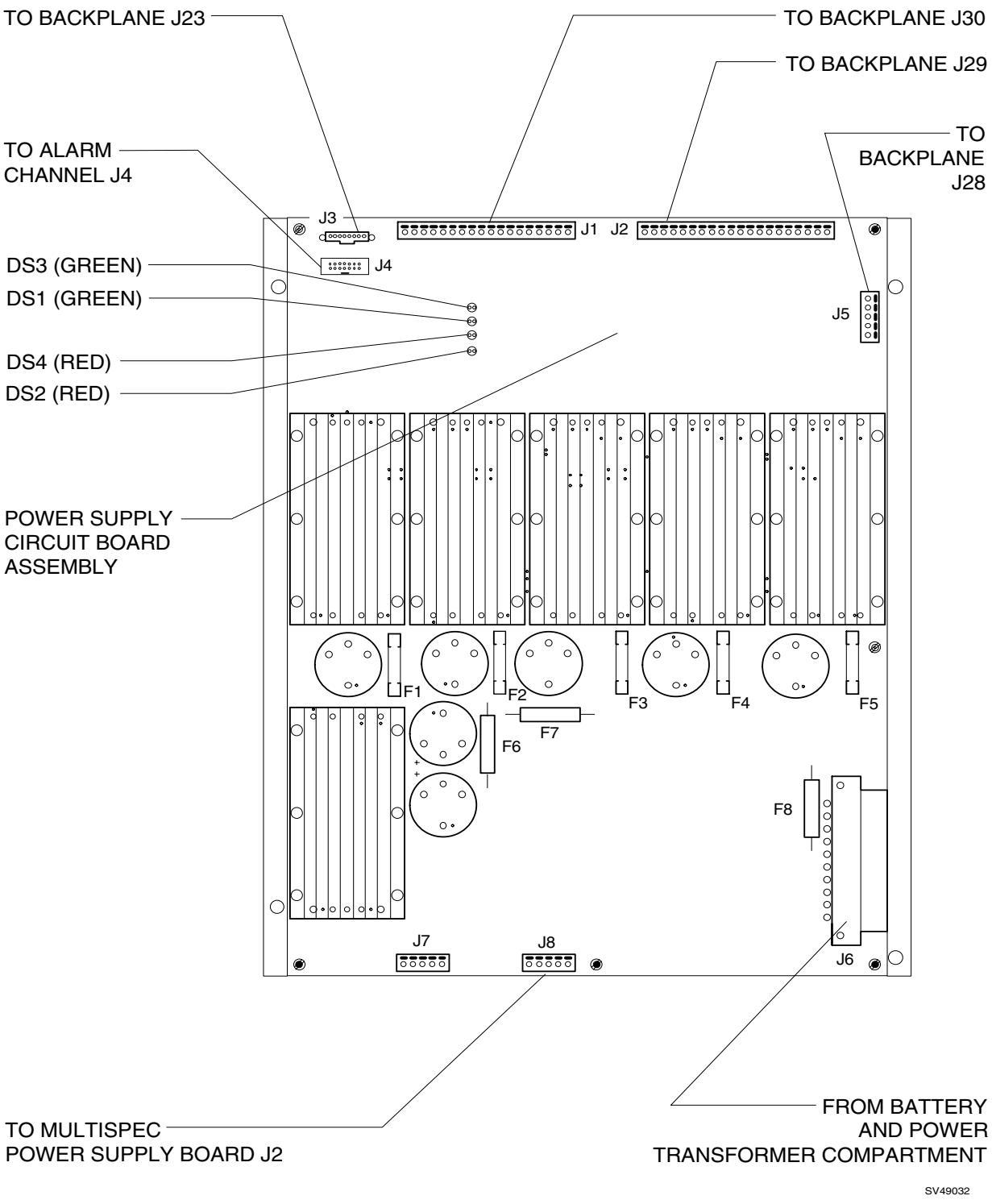



**Figure 3-2: POWER SUPPLY CIRCUIT BOARD CONNECTORS, LAMPS AND FUSES**

## 3.2 Processor Test

If a Processor related failure is reported, it will be flagged either as the "Main" or the "Back-Up" processor board. When the System Power switch is turned ON, the unit performs extensive self-diagnostics on its internal hardware. As the diagnostics are performed, each test and its result (PASS - FAIL) appear on the display. First the "Main" or upper processor board is tested and then the "Back-Up" or lower processor board is tested. If the "Back-Up" processor is reported defective, press the BACKUP key to obtain a more detailed display of what is non-functional on that board.

When diagnosing a processor related problem, use the BACKUP key to toggle between processors. As an additional diagnostic aid, the green lamp on the edge of each processor board, when lighted, indicates the presence of +5 VDC supplied to that board. Refer to the replacement procedures Section 4 for instructions on access to the processor boards.

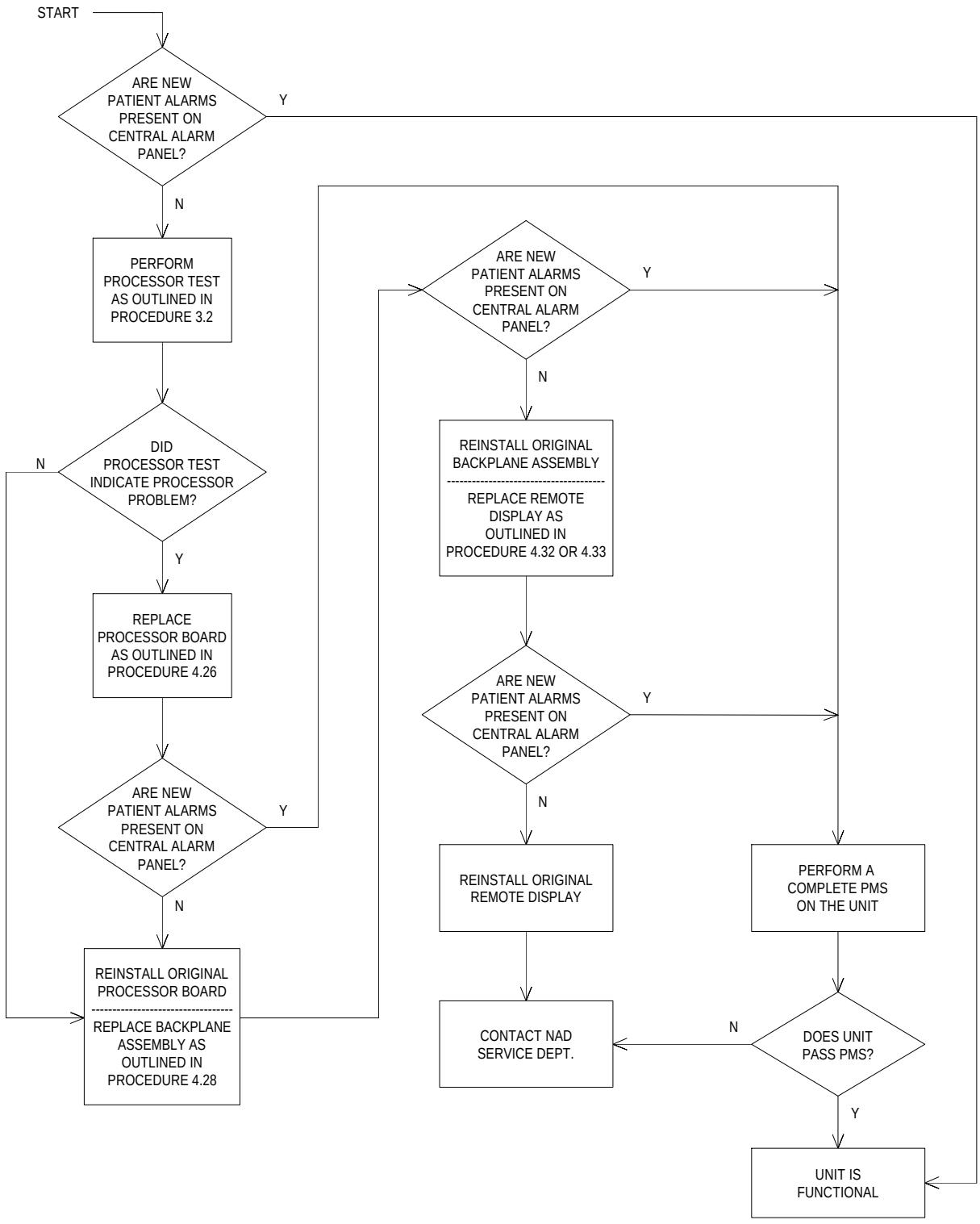
## 3.3 Troubleshooting Guide Flow Charts

Table 3-3 lists failure modes that could be detected during the power-up self test and the service diagnostic tests. Each failure mode is keyed to a troubleshooting guide flow chart to assist the Technical Service Representative in locating the problem. These flow charts assume that the machine is plugged into an AC outlet with the correct voltage, and the machine is not running on its backup battery.

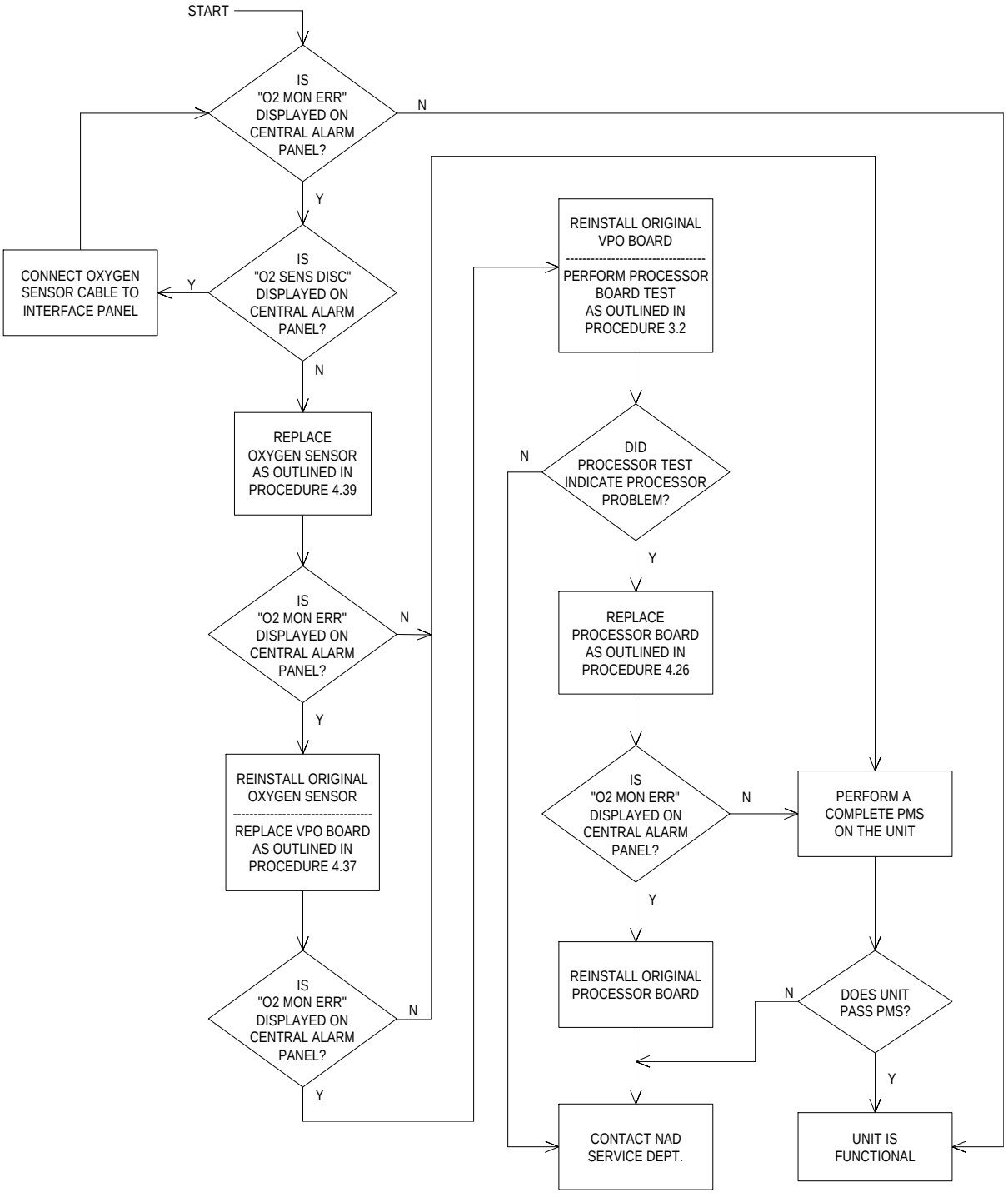
**Table 3-3: NARKOMED 4 TROUBLESHOOTING GUIDES**

| FAILURE MODE | CORRECTIVE ACTION |
|---|---|
| New Patient Alarm Not Displayed | GUIDE 1 |
| Loss of $O_2$ Monitor | GUIDE 2 |
| Loss of Breathing Pressure Monitor | GUIDE 3 |
| Loss of GAS Monitor | GUIDE 4 |
| Loss of Pulse Oximeter Monitor | GUIDE 5 |
| Loss of Respiratory Volume Monitor | GUIDE 6 |
| Loss of Blood Pressure Monitor | GUIDE 7 |
| Touch Screen Failure | GUIDE 8 |
| No Audio Alarms | GUIDE 9 |
| DataScan function not Logging Data | GUIDE 10 |
| Alarm Silence Failure | GUIDE 11 |
| Vitalink Failure | GUIDE 12 |
| Incorrect Display | GUIDE 13 |
| Measure Data Incorrect | GUIDE 14 |
| No Oxygen Ratio Monitor Alarm | GUIDE 15 |
| No Oxygen Supply Pressure Alarm | GUIDE 16 |
| Display Screens Blank upon System Power-Up | GUIDE 17 |
| Power Supply Voltages Out of Tolerance | GUIDE 18 |
| No Keypanel or Selection Dial Response | GUIDE 19 |
| Internal Printer Not Working | GUIDE 20 |

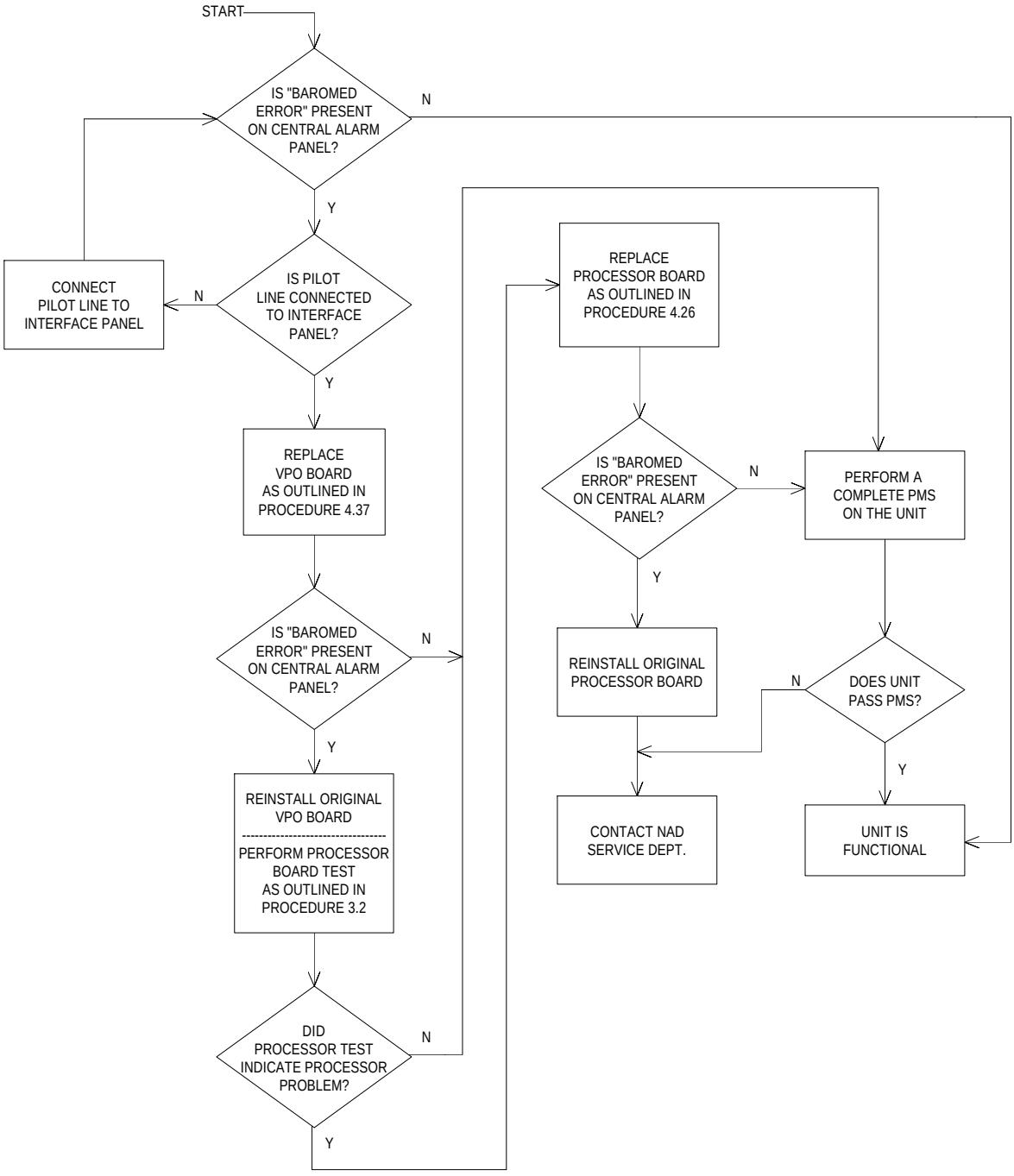
## GUIDE 1: New Patient Alarm Not Displayed


START
ARE NEW PATIENT ALARMS PRESENT ON CENTRAL ALARM PANEL?
Y
N
PERFORM PROCESSOR TEST AS OUTLINED IN PROCEDURE 3.2
DID PROCESSOR TEST INDICATE PROCESSOR PROBLEM?
N
Y
REPLACE PROCESSOR BOARD AS OUTLINED IN PROCEDURE 4.26
ARE NEW PATIENT ALARMS PRESENT ON CENTRAL ALARM PANEL?
Y
N
REINSTALL ORIGINAL PROCESSOR BOARD
REPLACE BACKPLANE ASSEMBLY AS OUTLINED IN PROCEDURE 4.28
ARE NEW PATIENT ALARMS PRESENT ON CENTRAL ALARM PANEL?
Y
N
REINSTALL ORIGINAL BACKPLANE ASSEMBLY
REPLACE REMOTE DISPLAY AS OUTLINED IN PROCEDURE 4.32 OR 4.33
ARE NEW PATIENT ALARMS PRESENT ON CENTRAL ALARM PANEL?
Y
N
REINSTALL ORIGINAL REMOTE DISPLAY
CONTACT NAD SERVICE DEPT.
PERFORM A COMPLETE PMS ON THE UNIT
DOES UNIT PASS PMS?
N
Y
UNIT IS FUNCTIONAL

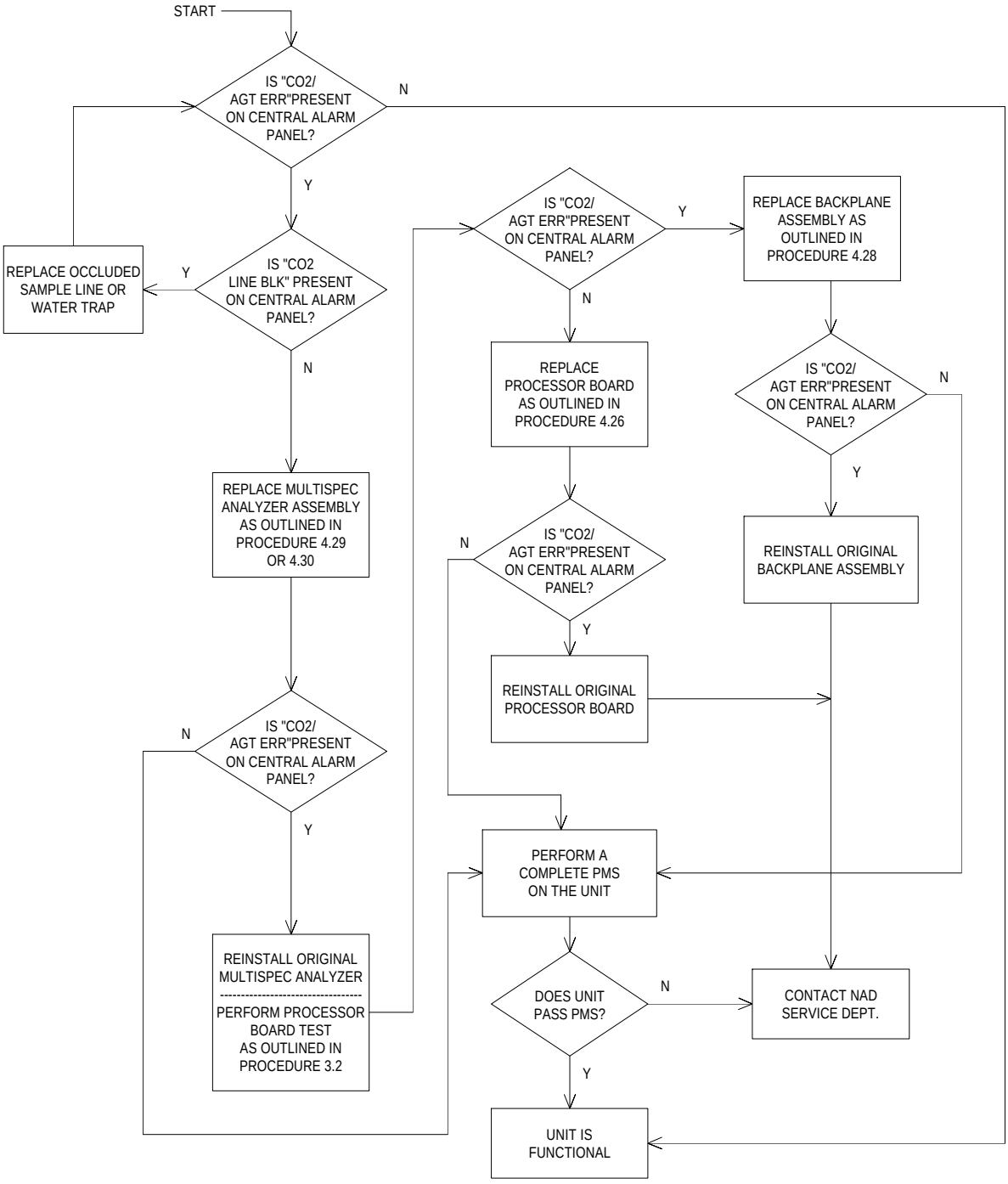
## GUIDE 2: Loss of $O_2$ Monitor


START
IS "O2 MON ERR" DISPLAYED ON CENTRAL ALARM PANEL?
N
Y
IS "O2 SENS DISC" DISPLAYED ON CENTRAL ALARM PANEL?
Y
CONNECT OXYGEN SENSOR CABLE TO INTERFACE PANEL
N
REPLACE OXYGEN SENSOR AS OUTLINED IN PROCEDURE 4.39
IS "O2 MON ERR" DISPLAYED ON CENTRAL ALARM PANEL?
N
Y
REINSTALL ORIGINAL OXYGEN SENSOR
REPLACE VPO BOARD AS OUTLINED IN PROCEDURE 4.37
IS "O2 MON ERR" DISPLAYED ON CENTRAL ALARM PANEL?
N
Y
REINSTALL ORIGINAL VPO BOARD
PERFORM PROCESSOR BOARD TEST AS OUTLINED IN PROCEDURE 3.2
DID PROCESSOR TEST INDICATE PROCESSOR PROBLEM?
N
Y
REPLACE PROCESSOR BOARD AS OUTLINED IN PROCEDURE 4.26
IS "O2 MON ERR" DISPLAYED ON CENTRAL ALARM PANEL?
N
Y
PERFORM A COMPLETE PMS ON THE UNIT
REINSTALL ORIGINAL PROCESSOR BOARD
DOES UNIT PASS PMS?
N
Y
CONTACT NAD SERVICE DEPT.
UNIT IS FUNCTIONAL

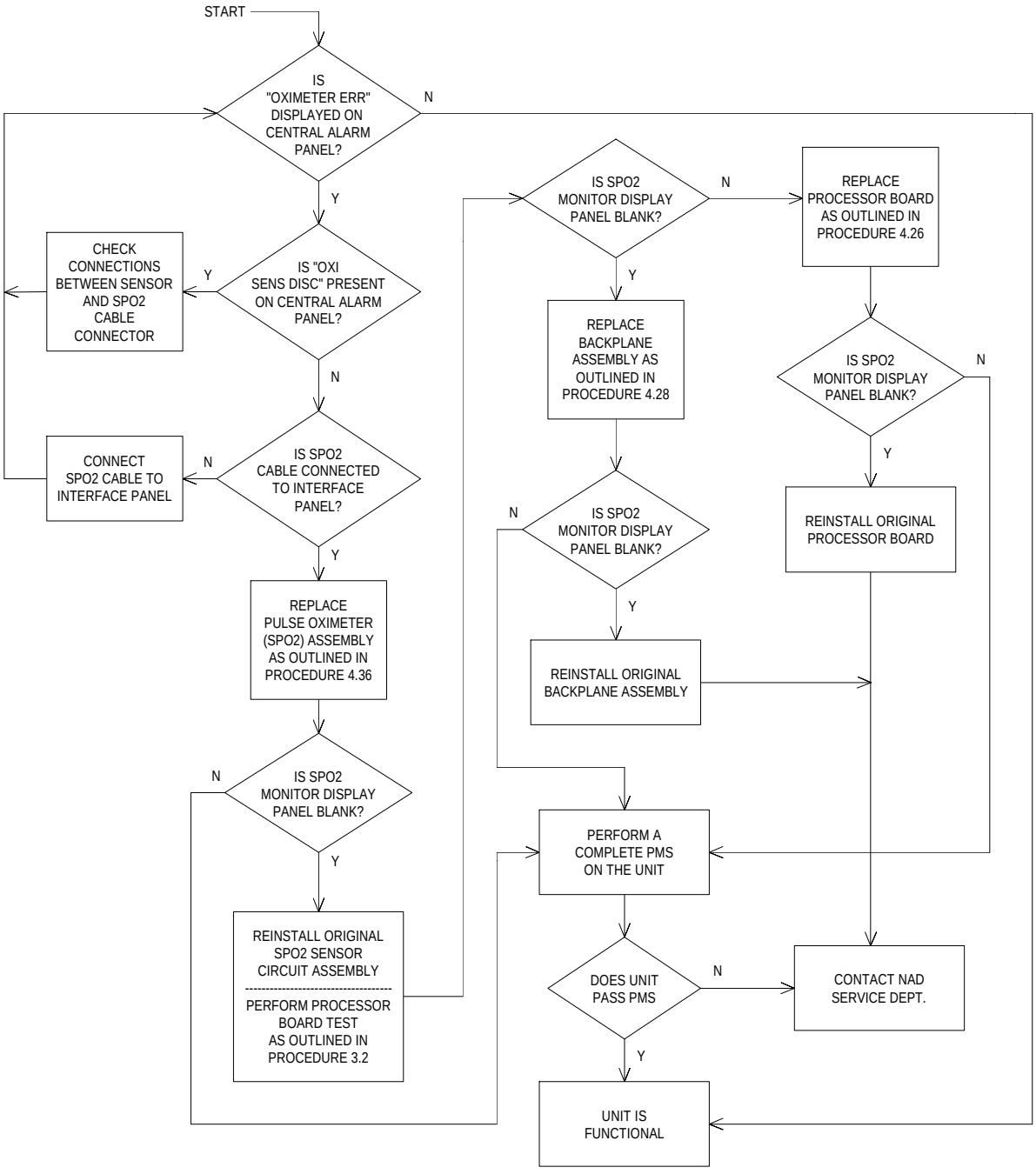
## GUIDE 3: Loss of Breathing Pressure Monitor



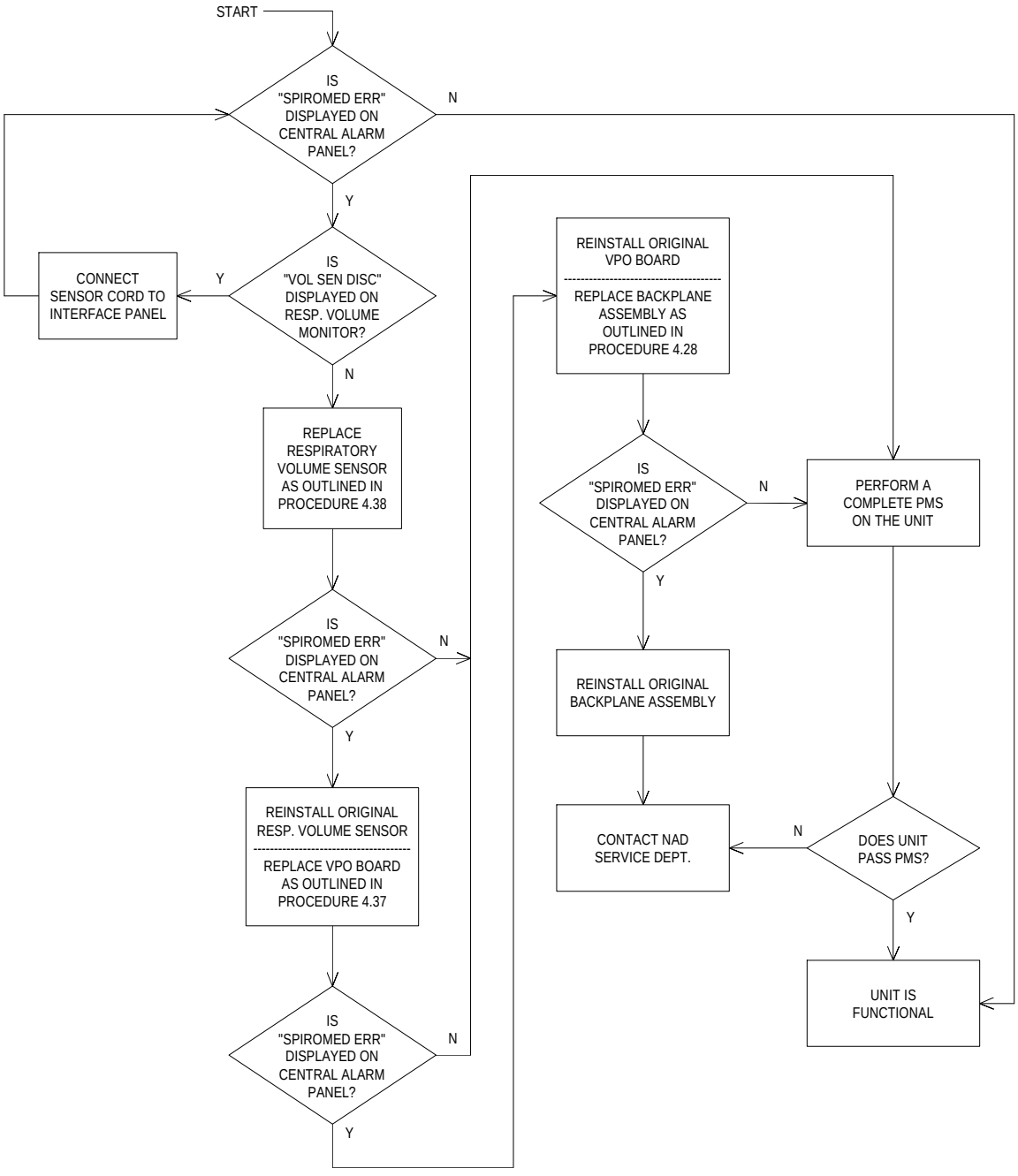
## GUIDE 4: Loss of GAS Monitor


START
IS "CO2/ AGT ERR"PRESENT ON CENTRAL ALARM PANEL?
N
Y
IS "CO2 LINE BLK" PRESENT ON CENTRAL ALARM PANEL?
Y
REPLACE OCCLUDED SAMPLE LINE OR WATER TRAP
N
REPLACE MULTISPEC ANALYZER ASSEMBLY AS OUTLINED IN PROCEDURE 4.29 OR 4.30
IS "CO2/ AGT ERR"PRESENT ON CENTRAL ALARM PANEL?
N
Y
REINSTALL ORIGINAL MULTISPEC ANALYZER
PERFORM PROCESSOR BOARD TEST AS OUTLINED IN PROCEDURE 3.2
IS "CO2/ AGT ERR"PRESENT ON CENTRAL ALARM PANEL?
Y
REPLACE BACKPLANE ASSEMBLY AS OUTLINED IN PROCEDURE 4.28
N
REPLACE PROCESSOR BOARD AS OUTLINED IN PROCEDURE 4.26
IS "CO2/ AGT ERR"PRESENT ON CENTRAL ALARM PANEL?
N
Y
REINSTALL ORIGINAL PROCESSOR BOARD
IS "CO2/ AGT ERR"PRESENT ON CENTRAL ALARM PANEL?
N
Y
REINSTALL ORIGINAL BACKPLANE ASSEMBLY
PERFORM A COMPLETE PMS ON THE UNIT
DOES UNIT PASS PMS?
N
CONTACT NAD SERVICE DEPT.
Y
UNIT IS FUNCTIONAL

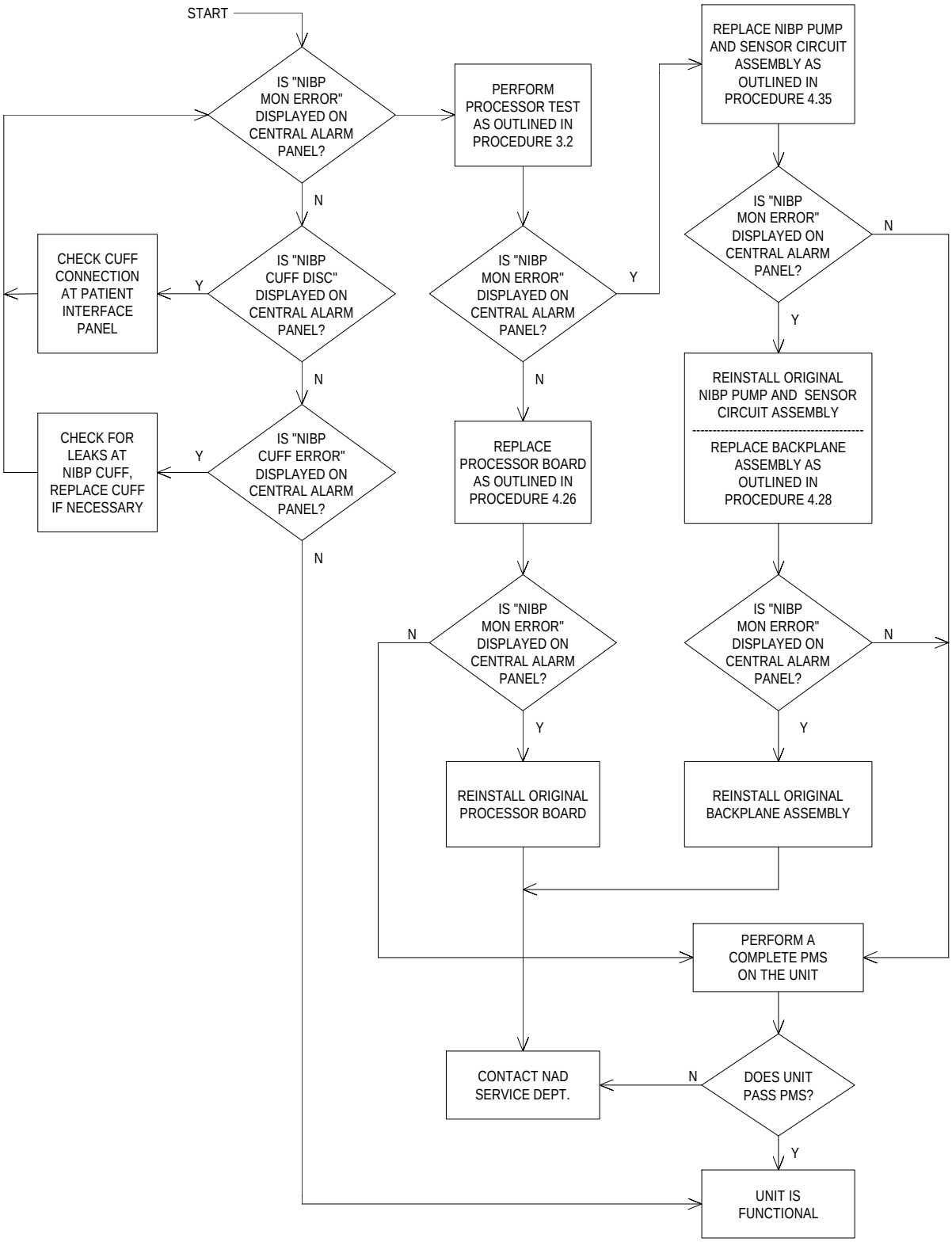
## GUIDE 5: Loss of Pulse Oximetry Monitor



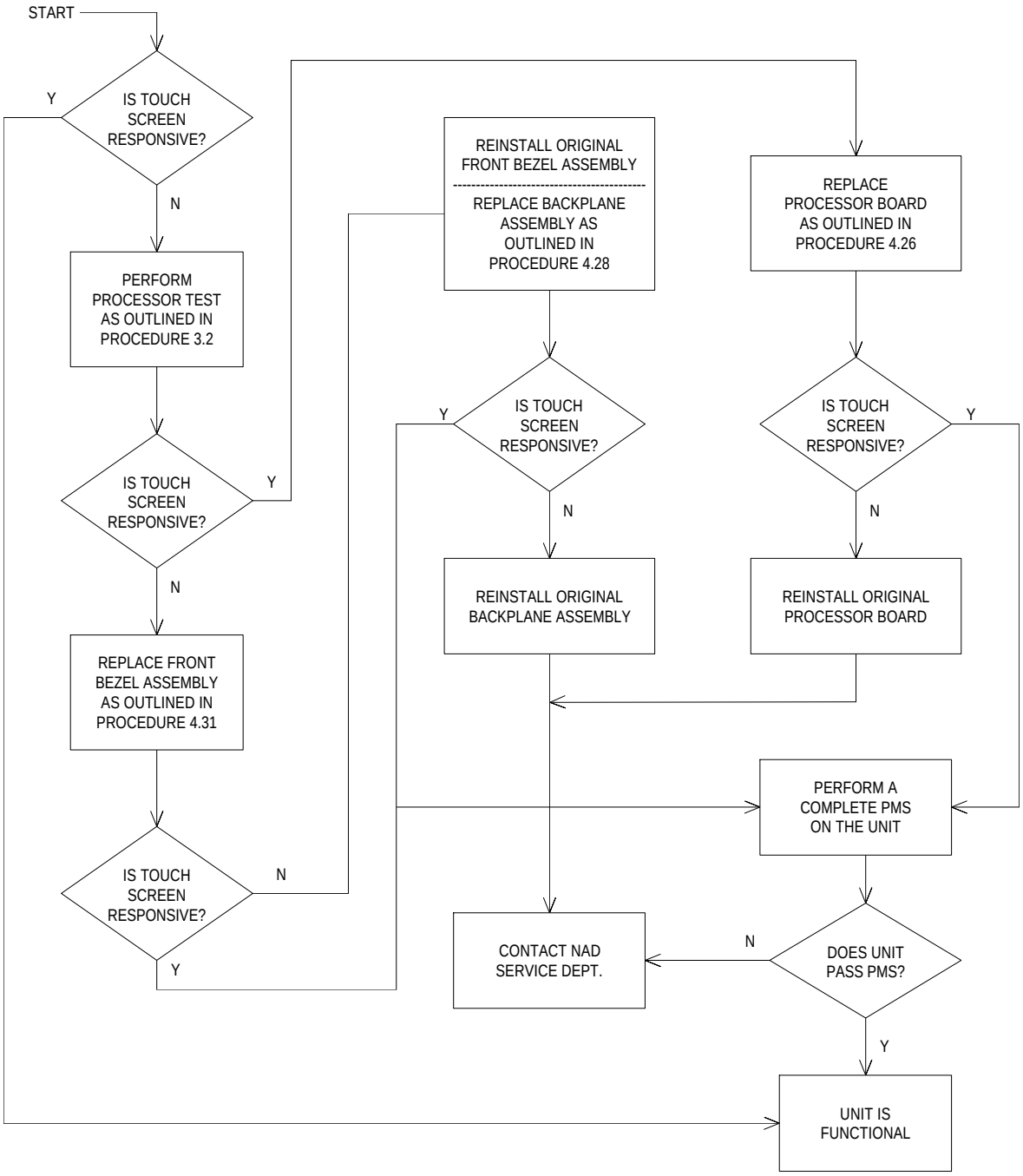
## GUIDE 6: Loss of Respiratory Volume Monitor


START
IS "SPIROMED ERR" DISPLAYED ON CENTRAL ALARM PANEL?
N
Y
IS "VOL SEN DISC" DISPLAYED ON RESP. VOLUME MONITOR?
Y
CONNECT SENSOR CORD TO INTERFACE PANEL
N
REPLACE RESPIRATORY VOLUME SENSOR AS OUTLINED IN PROCEDURE 4.38
IS "SPIROMED ERR" DISPLAYED ON CENTRAL ALARM PANEL?
N
Y
REINSTALL ORIGINAL RESP. VOLUME SENSOR
REPLACE VPO BOARD AS OUTLINED IN PROCEDURE 4.37
IS "SPIROMED ERR" DISPLAYED ON CENTRAL ALARM PANEL?
N
Y
REINSTALL ORIGINAL VPO BOARD
REPLACE BACKPLANE ASSEMBLY AS OUTLINED IN PROCEDURE 4.28
IS "SPIROMED ERR" DISPLAYED ON CENTRAL ALARM PANEL?
N
Y
PERFORM A COMPLETE PMS ON THE UNIT
REINSTALL ORIGINAL BACKPLANE ASSEMBLY
CONTACT NAD SERVICE DEPT.
N
DOES UNIT PASS PMS?
Y
UNIT IS FUNCTIONAL

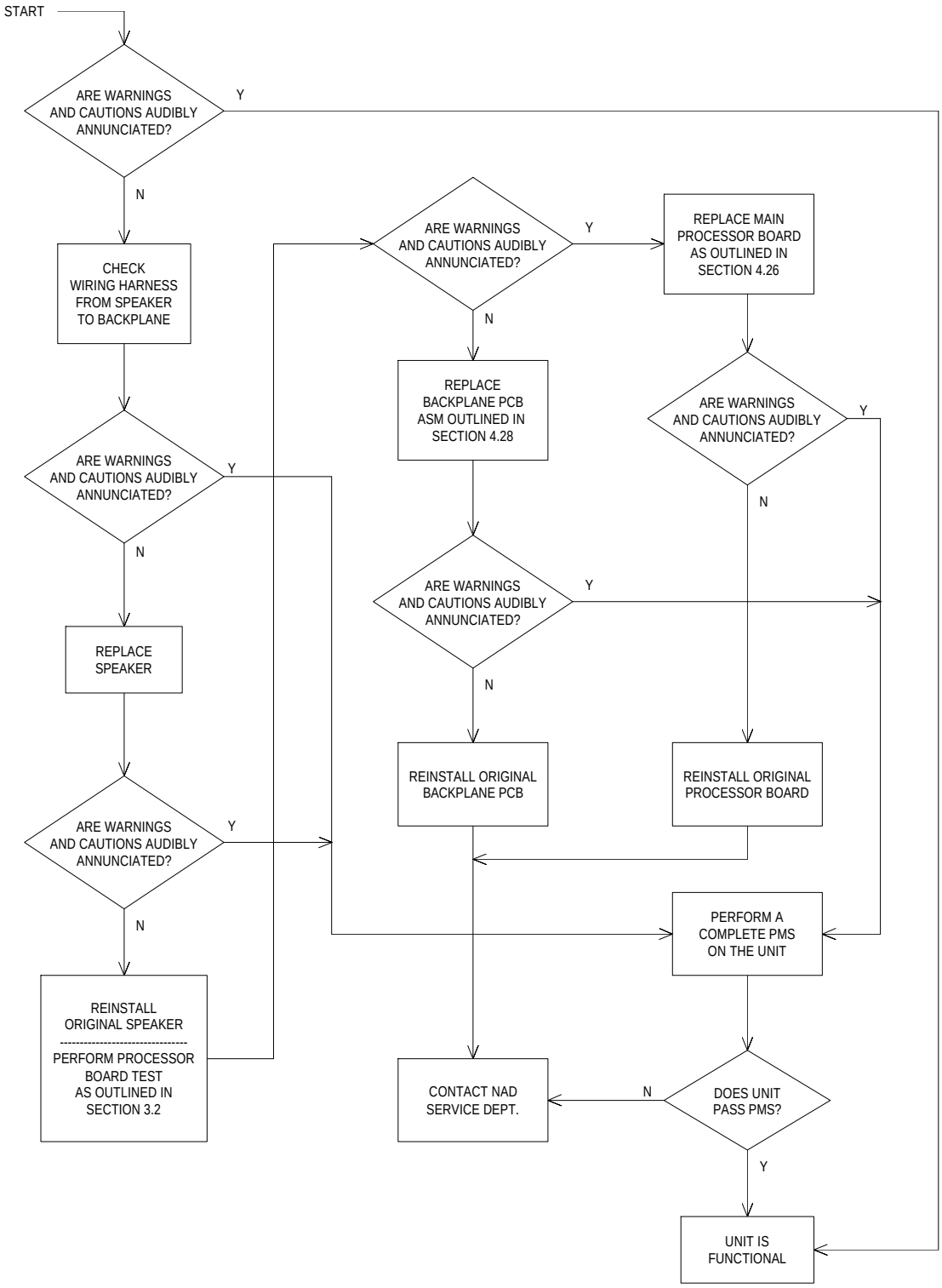
## GUIDE 7: Loss of Blood Pressure Monitor


START
IS "NIBP MON ERROR" DISPLAYED ON CENTRAL ALARM PANEL?
PERFORM PROCESSOR TEST AS OUTLINED IN PROCEDURE 3.2
REPLACE NIBP PUMP AND SENSOR CIRCUIT ASSEMBLY AS OUTLINED IN PROCEDURE 4.35
N
IS "NIBP MON ERROR" DISPLAYED ON CENTRAL ALARM PANEL?
Y
IS "NIBP MON ERROR" DISPLAYED ON CENTRAL ALARM PANEL?
N
Y
CHECK CUFF CONNECTION AT PATIENT INTERFACE PANEL
Y
IS "NIBP CUFF DISC" DISPLAYED ON CENTRAL ALARM PANEL?
N
REINSTALL ORIGINAL NIBP PUMP AND SENSOR CIRCUIT ASSEMBLY
REPLACE BACKPLANE ASSEMBLY AS OUTLINED IN PROCEDURE 4.28
CHECK FOR LEAKS AT NIBP CUFF, REPLACE CUFF IF NECESSARY
Y
IS "NIBP CUFF ERROR" DISPLAYED ON CENTRAL ALARM PANEL?
N
REPLACE PROCESSOR BOARD AS OUTLINED IN PROCEDURE 4.26
IS "NIBP MON ERROR" DISPLAYED ON CENTRAL ALARM PANEL?
N
IS "NIBP MON ERROR" DISPLAYED ON CENTRAL ALARM PANEL?
N
Y
Y
REINSTALL ORIGINAL PROCESSOR BOARD
REINSTALL ORIGINAL BACKPLANE ASSEMBLY
PERFORM A COMPLETE PMS ON THE UNIT
CONTACT NAD SERVICE DEPT.
N
DOES UNIT PASS PMS?
Y
UNIT IS FUNCTIONAL

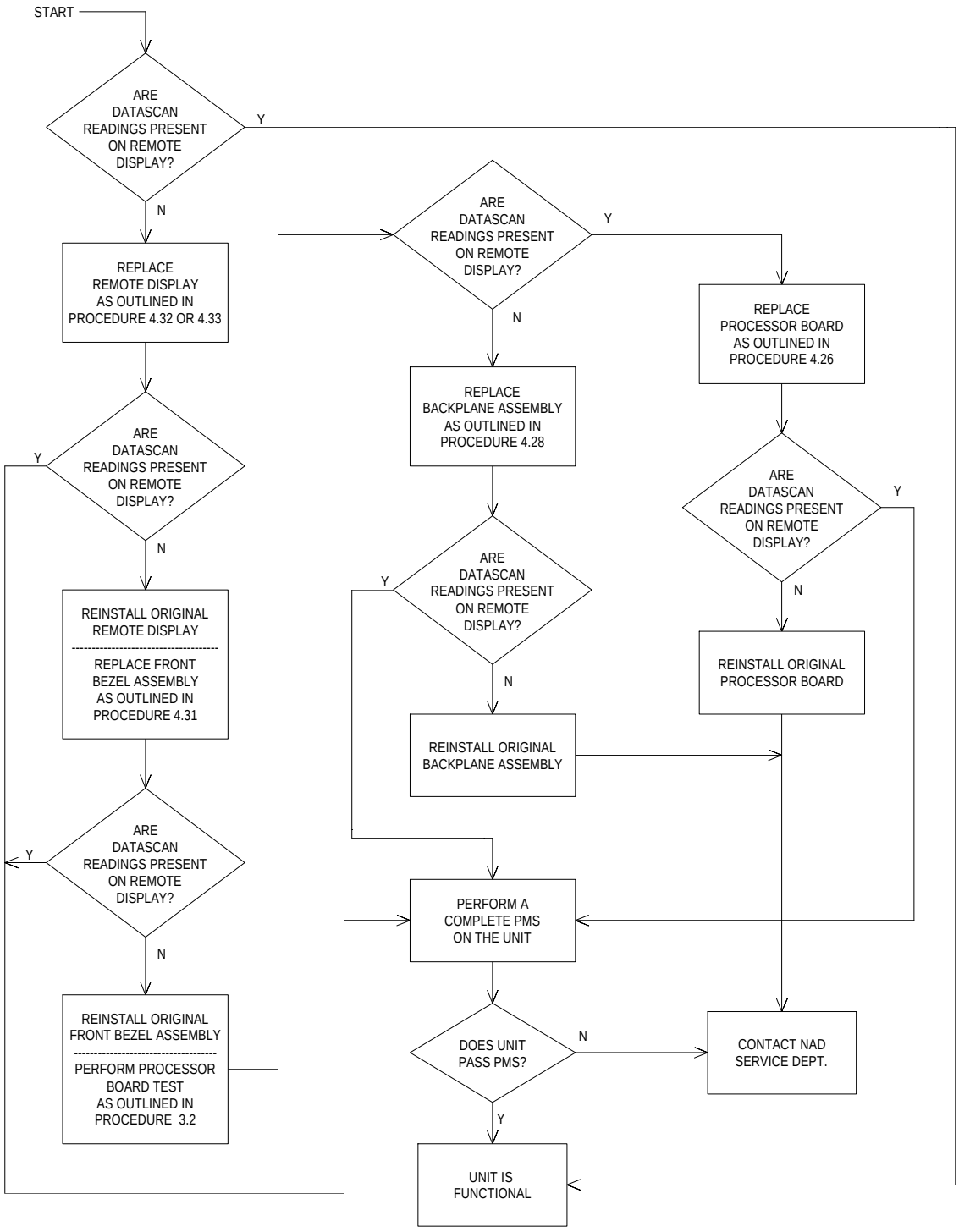
## GUIDE 8: Touch Screen Failure



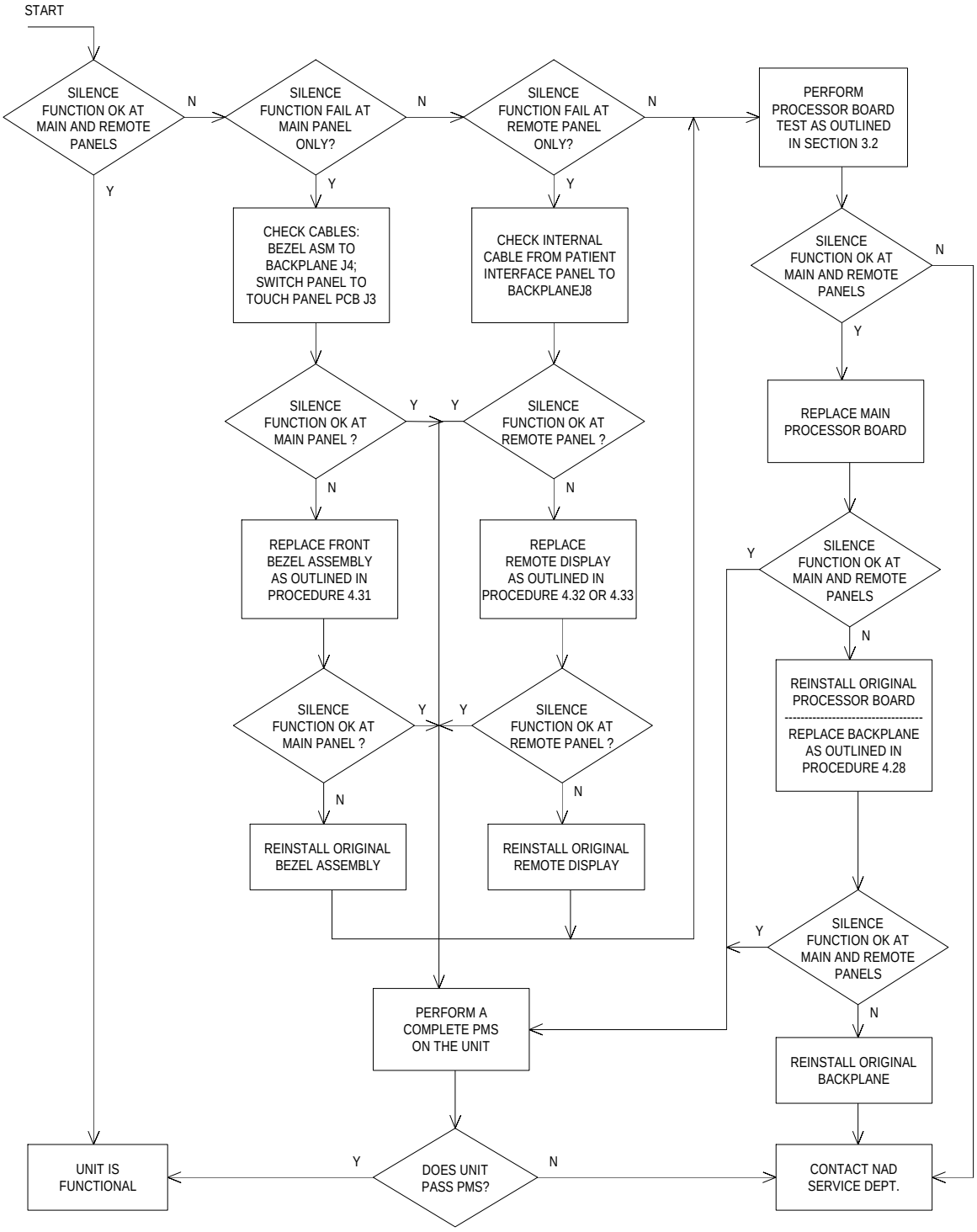
## GUIDE 9: No Audio Alarms



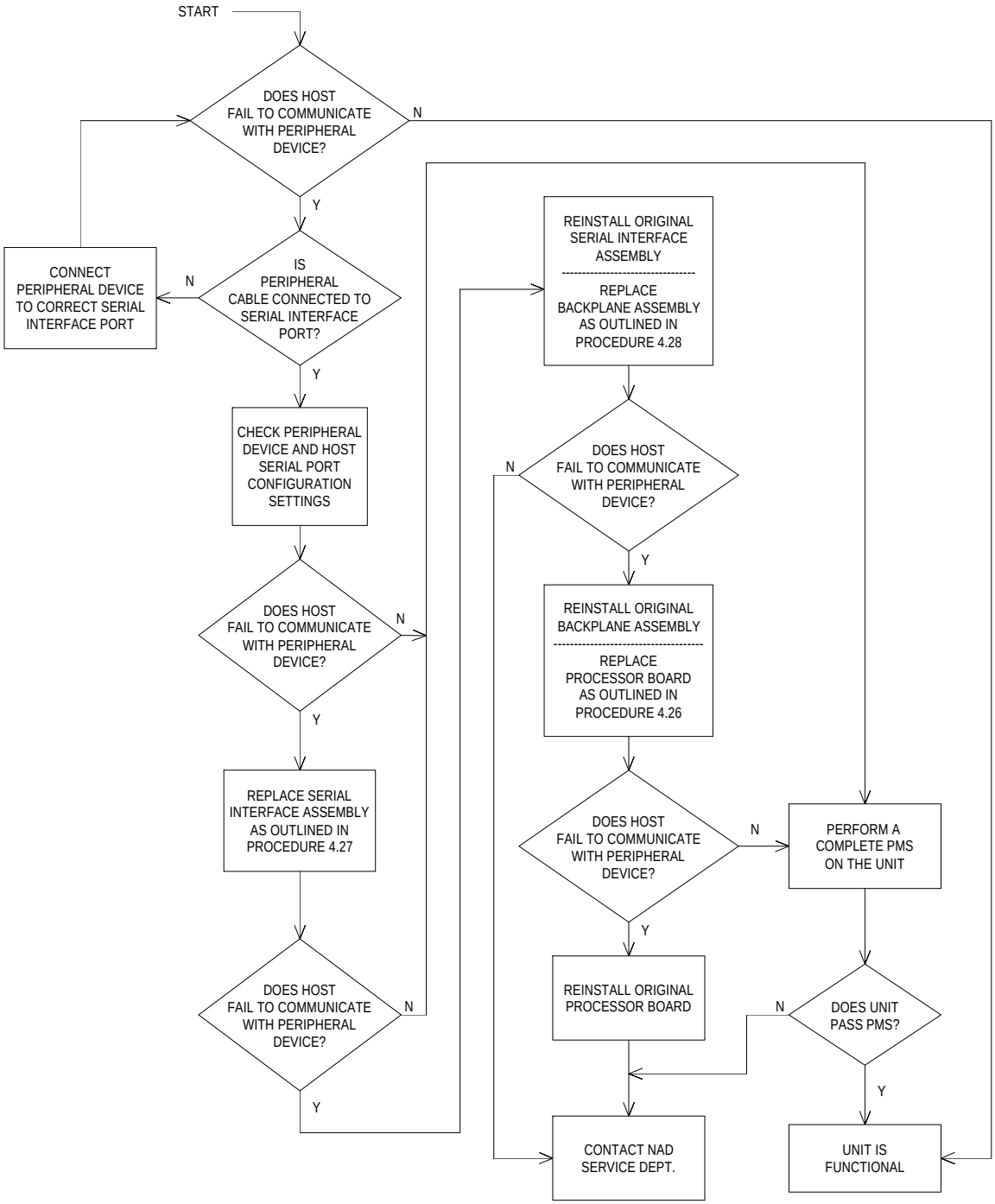
## GUIDE 10: DataScan Function not Logging Data


START
ARE DATASCAN READINGS PRESENT ON REMOTE DISPLAY?
Y
N
REPLACE REMOTE DISPLAY AS OUTLINED IN PROCEDURE 4.32 OR 4.33
ARE DATASCAN READINGS PRESENT ON REMOTE DISPLAY?
Y
N
REINSTALL ORIGINAL REMOTE DISPLAY
REPLACE FRONT BEZEL ASSEMBLY AS OUTLINED IN PROCEDURE 4.31
ARE DATASCAN READINGS PRESENT ON REMOTE DISPLAY?
Y
N
REINSTALL ORIGINAL FRONT BEZEL ASSEMBLY
PERFORM PROCESSOR BOARD TEST AS OUTLINED IN PROCEDURE 3.2
ARE DATASCAN READINGS PRESENT ON REMOTE DISPLAY?
Y
N
REPLACE BACKPLANE ASSEMBLY AS OUTLINED IN PROCEDURE 4.28
ARE DATASCAN READINGS PRESENT ON REMOTE DISPLAY?
Y
N
REINSTALL ORIGINAL BACKPLANE ASSEMBLY
REPLACE PROCESSOR BOARD AS OUTLINED IN PROCEDURE 4.26
ARE DATASCAN READINGS PRESENT ON REMOTE DISPLAY?
Y
N
REINSTALL ORIGINAL PROCESSOR BOARD
PERFORM A COMPLETE PMS ON THE UNIT
DOES UNIT PASS PMS?
N
CONTACT NAD SERVICE DEPT.
Y
UNIT IS FUNCTIONAL

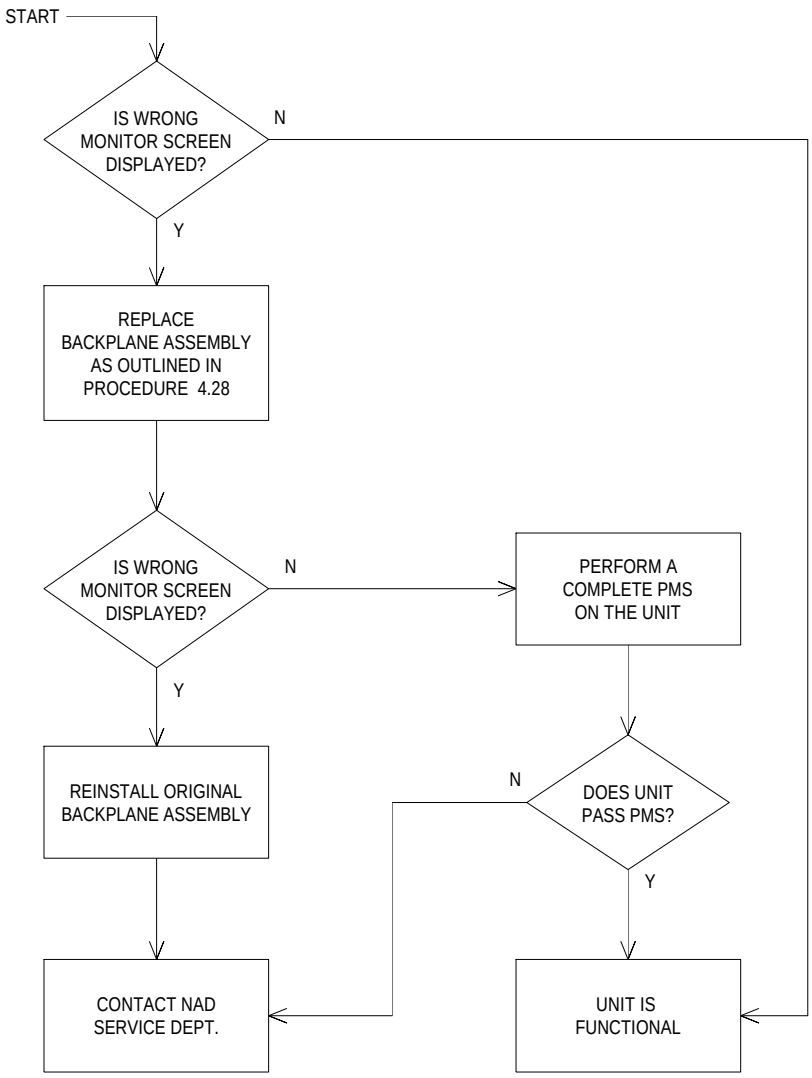
## GUIDE 11: Alarm Silence Failure


START
SILENCE FUNCTION OK AT MAIN AND REMOTE PANELS
N
SILENCE FUNCTION FAIL AT MAIN PANEL ONLY?
N
SILENCE FUNCTION FAIL AT REMOTE PANEL ONLY?
N
PERFORM PROCESSOR BOARD TEST AS OUTLINED IN SECTION 3.2
Y
Y
Y
CHECK CABLES: BEZEL ASM TO BACKPLANE J4; SWITCH PANEL TO TOUCH PANEL PCB J3
CHECK INTERNAL CABLE FROM PATIENT INTERFACE PANEL TO BACKPLANEJ8
SILENCE FUNCTION OK AT MAIN AND REMOTE PANELS
N
Y
SILENCE FUNCTION OK AT MAIN PANEL ?
Y
Y
SILENCE FUNCTION OK AT REMOTE PANEL ?
REPLACE MAIN PROCESSOR BOARD
N
N
REPLACE FRONT BEZEL ASSEMBLY AS OUTLINED IN PROCEDURE 4.31
REPLACE REMOTE DISPLAY AS OUTLINED IN PROCEDURE 4.32 OR 4.33
Y
SILENCE FUNCTION OK AT MAIN AND REMOTE PANELS
N
SILENCE FUNCTION OK AT MAIN PANEL ?
Y
Y
SILENCE FUNCTION OK AT REMOTE PANEL ?
REINSTALL ORIGINAL PROCESSOR BOARD
REPLACE BACKPLANE AS OUTLINED IN PROCEDURE 4.28
N
N
REINSTALL ORIGINAL BEZEL ASSEMBLY
REINSTALL ORIGINAL REMOTE DISPLAY
Y
SILENCE FUNCTION OK AT MAIN AND REMOTE PANELS
N
PERFORM A COMPLETE PMS ON THE UNIT
REINSTALL ORIGINAL BACKPLANE
UNIT IS FUNCTIONAL
Y
DOES UNIT PASS PMS?
N
CONTACT NAD SERVICE DEPT.

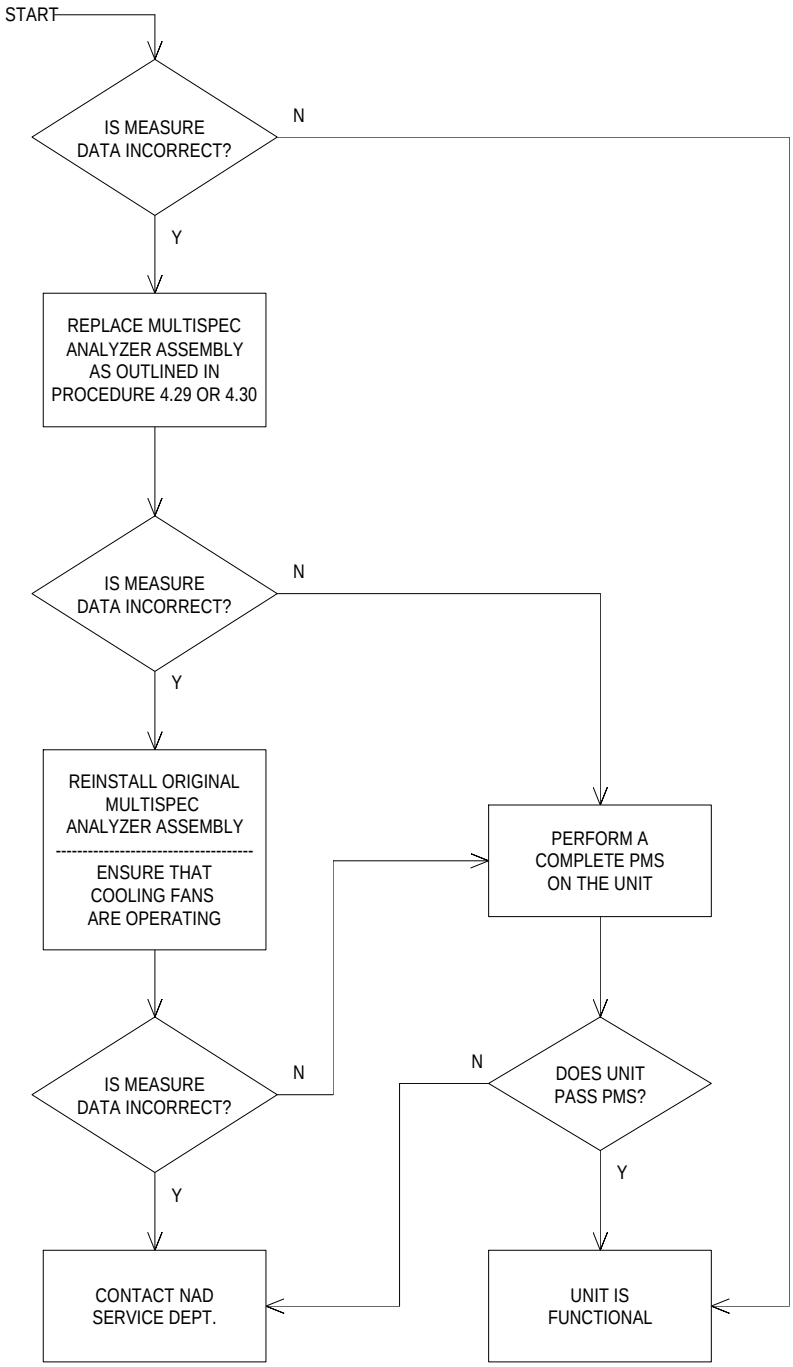
## GUIDE 12: Vitalink Failure


START
DOES HOST FAIL TO COMMUNICATE WITH PERIPHERAL DEVICE?
N
Y
CONNECT PERIPHERAL DEVICE TO CORRECT SERIAL INTERFACE PORT
N
IS PERIPHERAL CABLE CONNECTED TO SERIAL INTERFACE PORT?
Y
CHECK PERIPHERAL DEVICE AND HOST SERIAL PORT CONFIGURATION SETTINGS
DOES HOST FAIL TO COMMUNICATE WITH PERIPHERAL DEVICE?
N
Y
REPLACE SERIAL INTERFACE ASSEMBLY AS OUTLINED IN PROCEDURE 4.27
DOES HOST FAIL TO COMMUNICATE WITH PERIPHERAL DEVICE?
N
Y
REINSTALL ORIGINAL SERIAL INTERFACE ASSEMBLY
REPLACE BACKPLANE ASSEMBLY AS OUTLINED IN PROCEDURE 4.28
DOES HOST FAIL TO COMMUNICATE WITH PERIPHERAL DEVICE?
N
Y
REINSTALL ORIGINAL BACKPLANE ASSEMBLY
REPLACE PROCESSOR BOARD AS OUTLINED IN PROCEDURE 4.26
DOES HOST FAIL TO COMMUNICATE WITH PERIPHERAL DEVICE?
N
Y
REINSTALL ORIGINAL PROCESSOR BOARD
PERFORM A COMPLETE PMS ON THE UNIT
DOES UNIT PASS PMS?
N
Y
CONTACT NAD SERVICE DEPT.
UNIT IS FUNCTIONAL

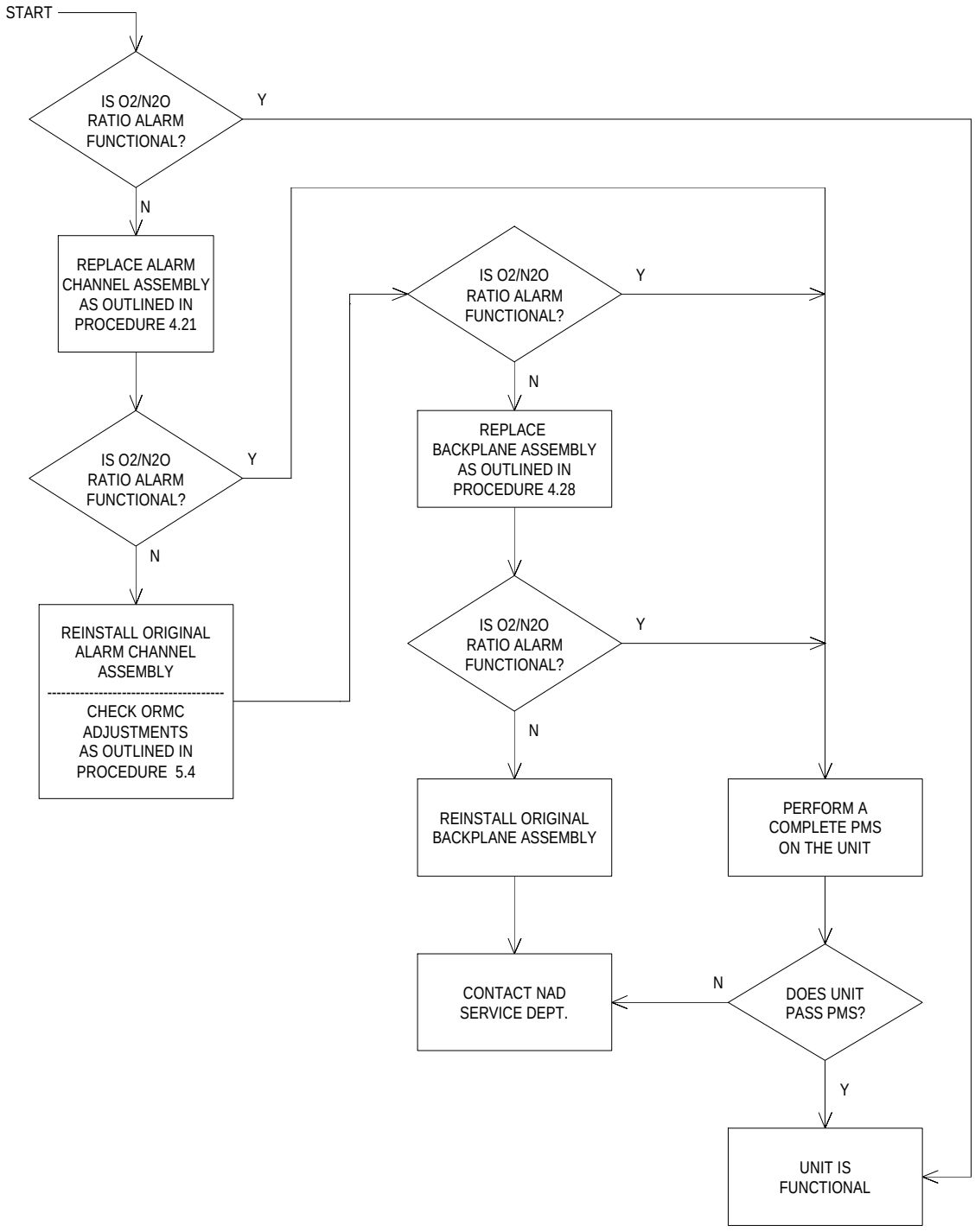
## GUIDE 13: Incorrect Display



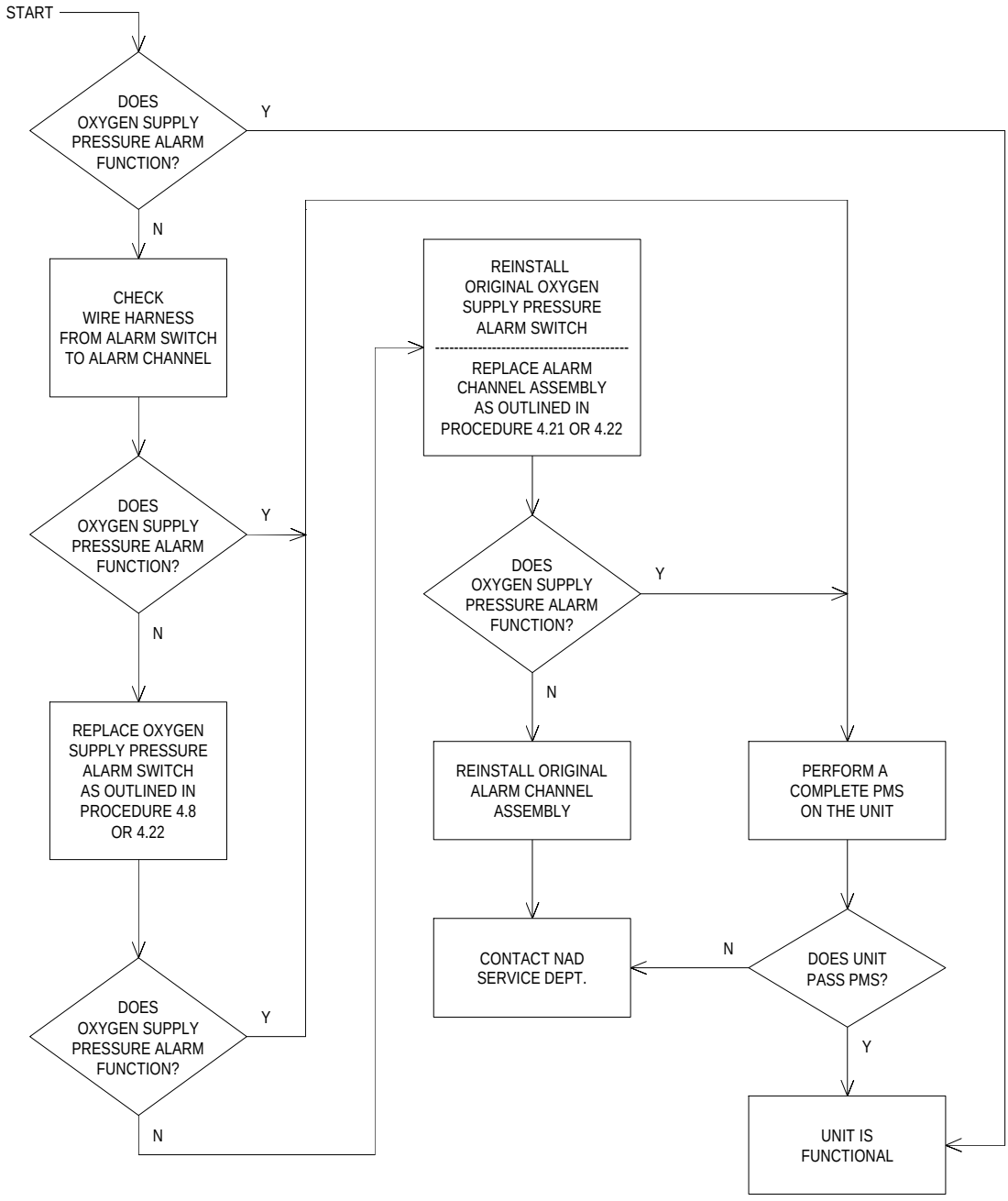
## GUIDE 14: Measure Data Incorrect



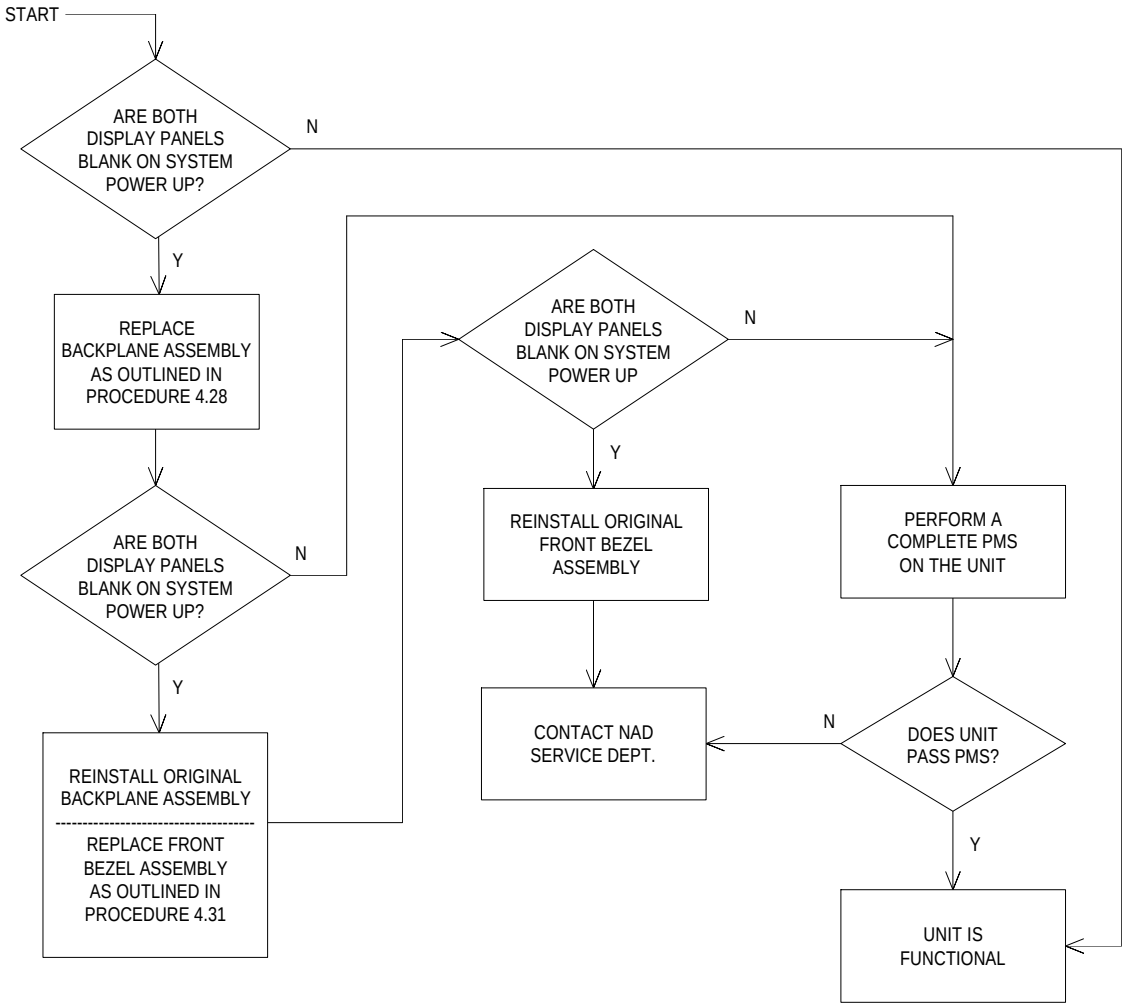
## GUIDE 15: No Oxygen Ratio Monitor Alarm



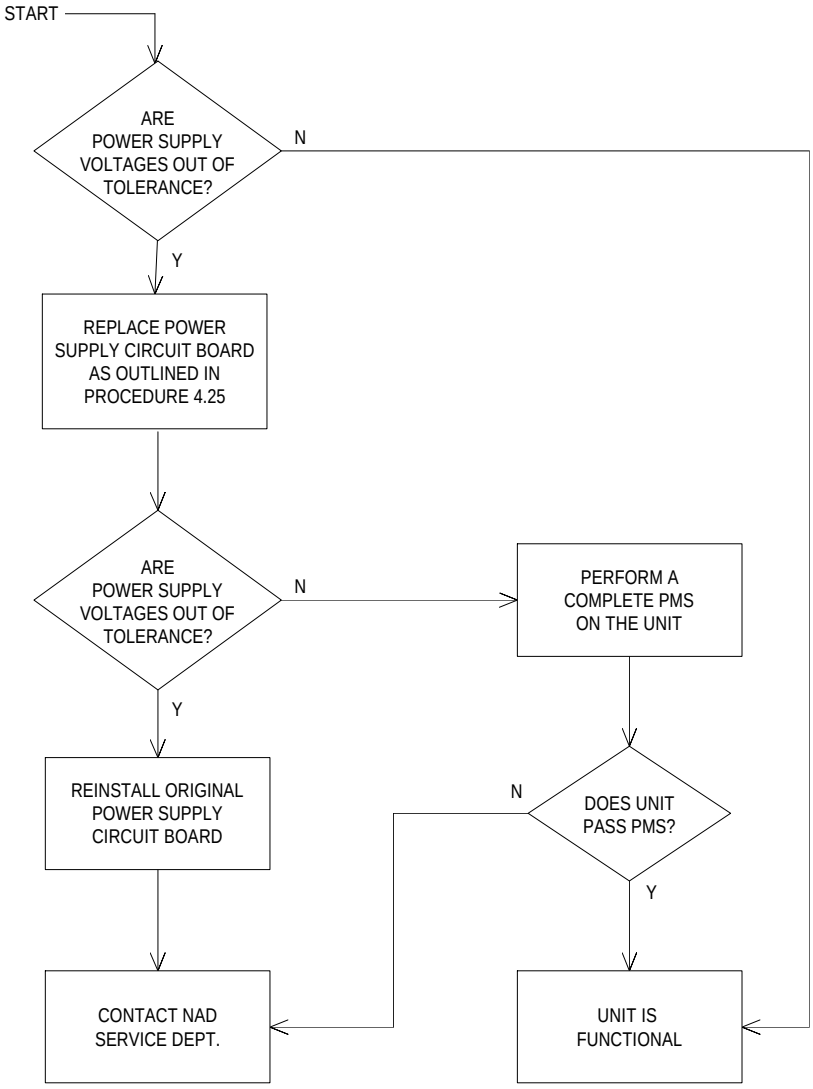
## GUIDE 16: No Oxygen Supply Pressure Alarm


START
DOES OXYGEN SUPPLY PRESSURE ALARM FUNCTION?
Y
N
CHECK WIRE HARNESS FROM ALARM SWITCH TO ALARM CHANNEL
DOES OXYGEN SUPPLY PRESSURE ALARM FUNCTION?
Y
N
REPLACE OXYGEN SUPPLY PRESSURE ALARM SWITCH AS OUTLINED IN PROCEDURE 4.8 OR 4.22
DOES OXYGEN SUPPLY PRESSURE ALARM FUNCTION?
Y
N
REINSTALL ORIGINAL OXYGEN SUPPLY PRESSURE ALARM SWITCH
REPLACE ALARM CHANNEL ASSEMBLY AS OUTLINED IN PROCEDURE 4.21 OR 4.22
DOES OXYGEN SUPPLY PRESSURE ALARM FUNCTION?
Y
N
REINSTALL ORIGINAL ALARM CHANNEL ASSEMBLY
CONTACT NAD SERVICE DEPT.
PERFORM A COMPLETE PMS ON THE UNIT
DOES UNIT PASS PMS?
N
Y
UNIT IS FUNCTIONAL

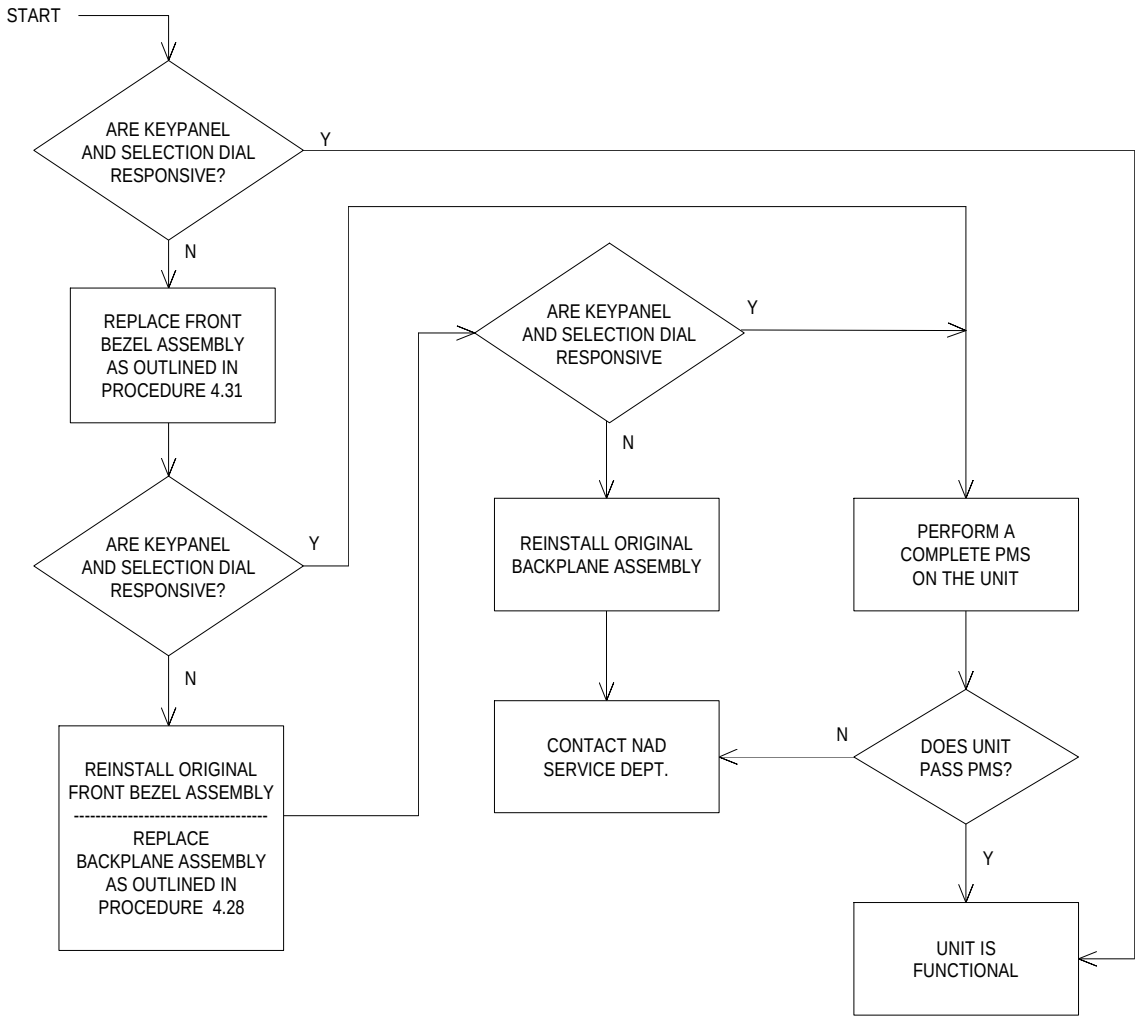
## GUIDE 17: Display Screens Blank upon System Power-Up


START
ARE BOTH DISPLAY PANELS BLANK ON SYSTEM POWER UP?
N
Y
REPLACE BACKPLANE ASSEMBLY AS OUTLINED IN PROCEDURE 4.28
ARE BOTH DISPLAY PANELS BLANK ON SYSTEM POWER UP
N
Y
REINSTALL ORIGINAL FRONT BEZEL ASSEMBLY
PERFORM A COMPLETE PMS ON THE UNIT
ARE BOTH DISPLAY PANELS BLANK ON SYSTEM POWER UP?
N
Y
REINSTALL ORIGINAL BACKPLANE ASSEMBLY
REPLACE FRONT BEZEL ASSEMBLY AS OUTLINED IN PROCEDURE 4.31
CONTACT NAD SERVICE DEPT.
N
DOES UNIT PASS PMS?
Y
UNIT IS FUNCTIONAL

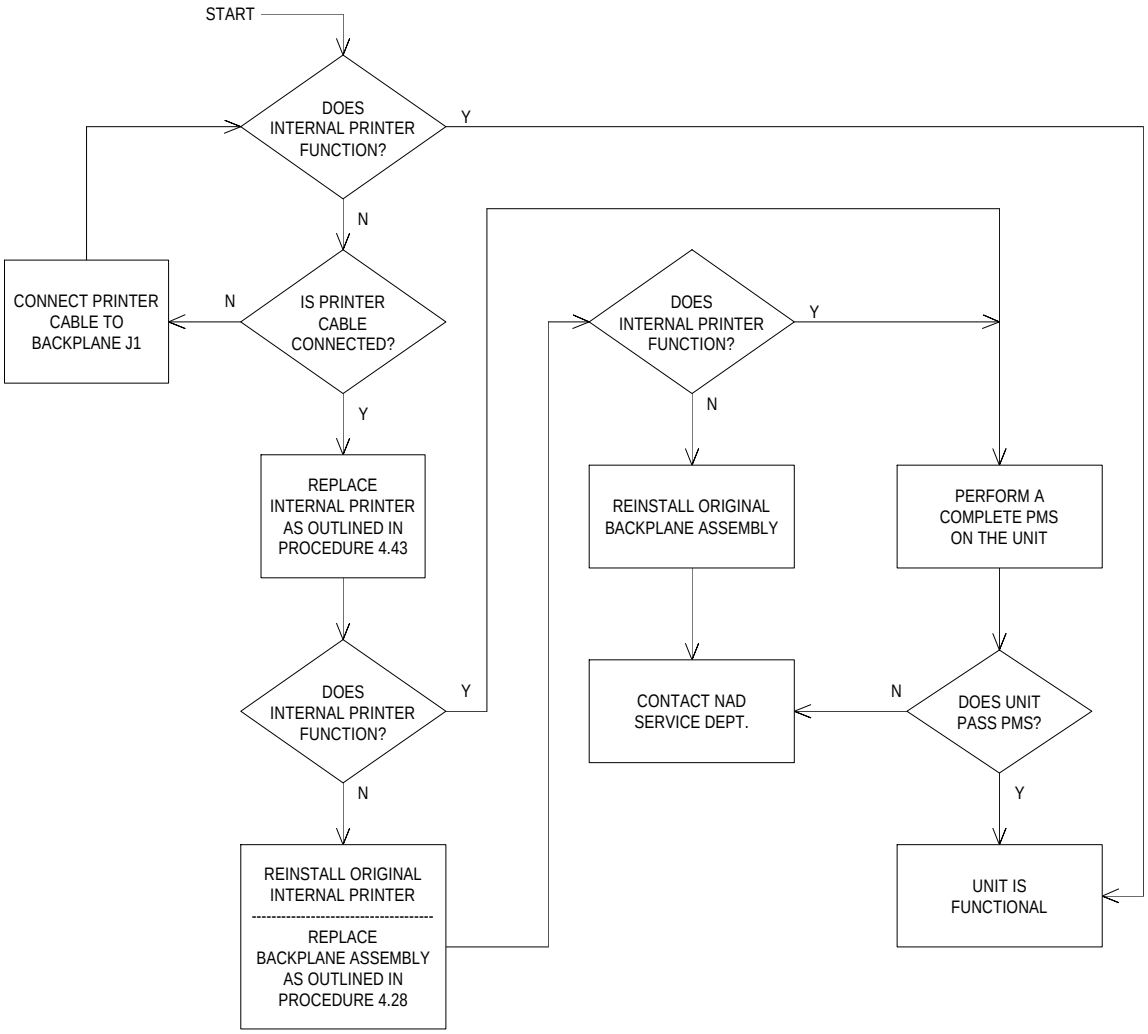
## GUIDE 18: Power Supply Voltages Out of Tolerance



## GUIDE 19: No Keypanel or Selection Dial Response



## GUIDE 20: Internal Printer Not Working



## 3.4 O.R. DATA MANAGER Troubleshooting

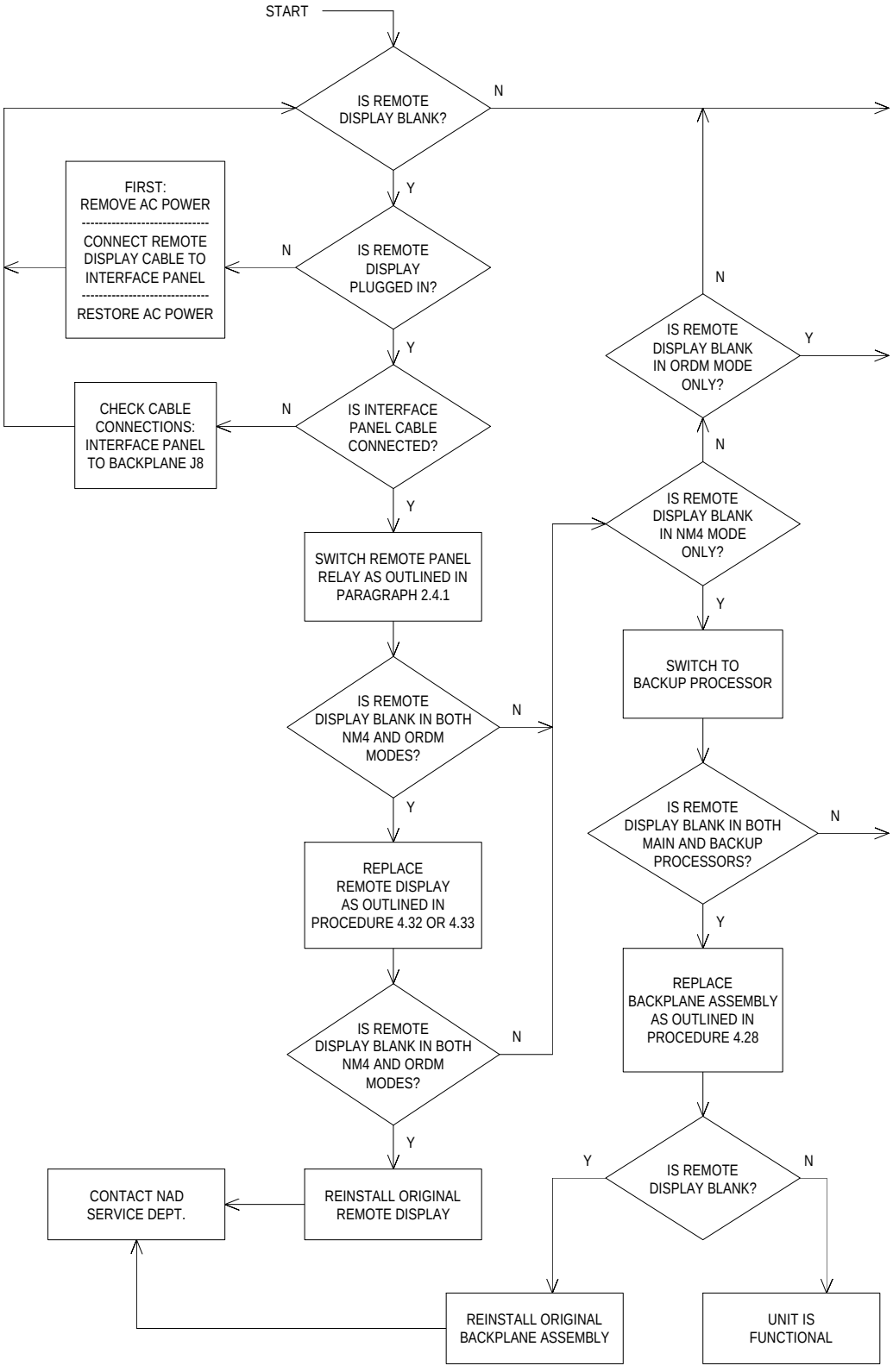
Table 3-4 lists failure modes and symptoms for the O.R. DATA MANAGER. Those that are marked (*) in the table are messages that can appear on the Remote Display during the power-up self test. Each failure mode or symptom is keyed to a recommended action to assist the TSR in locating a problem.

Refer to the Replacement Procedures section for instructions on access to the O.R. DATA MANAGER CPU assembly, cable connections and keyboard.

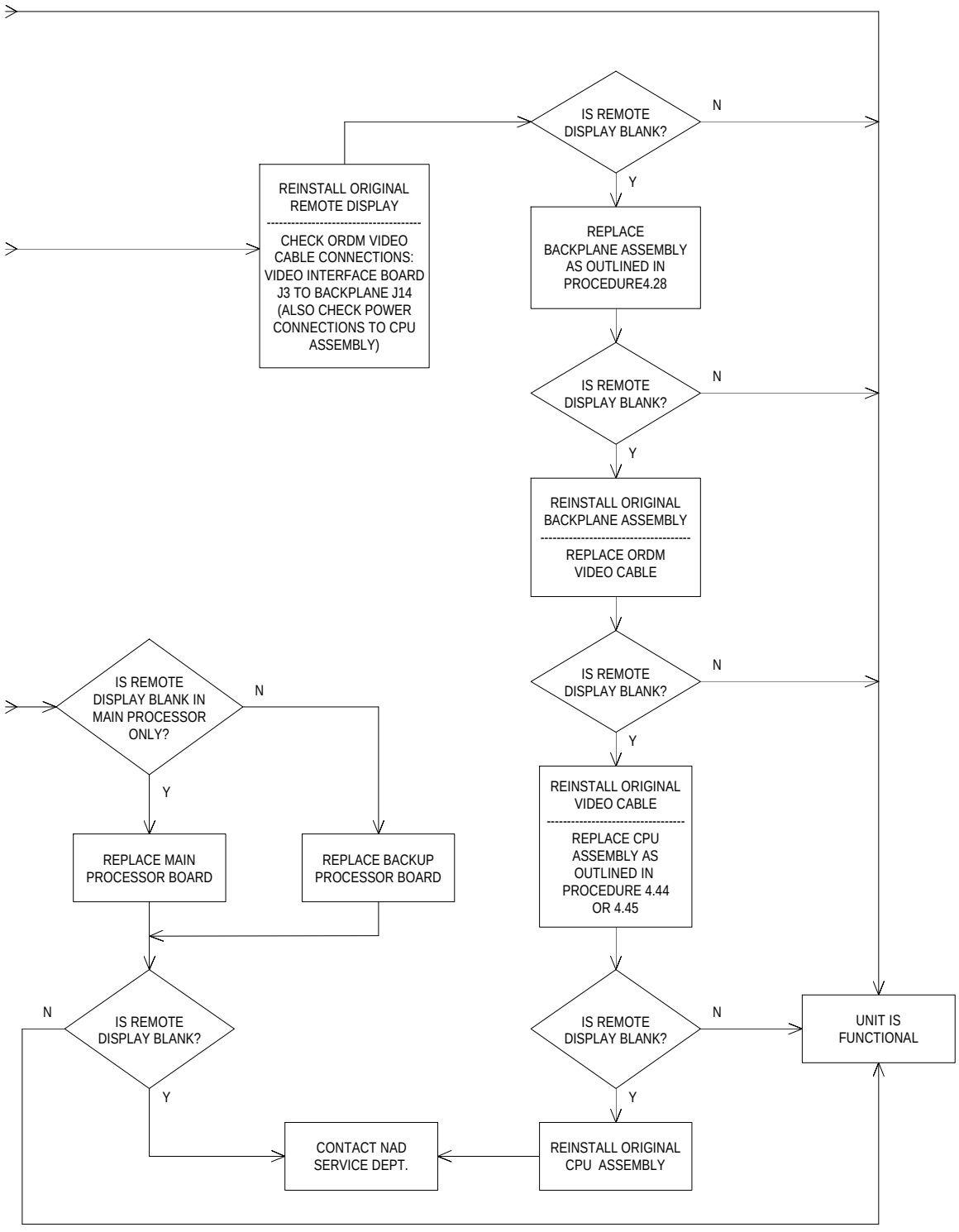
**TABLE 3-4: O. R. DATA MANAGER FAILURE MODES AND SYMPTOM LIST**

| FAILURE MODE OR SYMPTOM | ACTION |
|---|---|
| Display Blank | GUIDE 21 |
| *Keyboard Error or Keyboard Not Present | GUIDE 22 |
| *Internal Diagnostic Failure upon System Power-Up | GUIDE 23 |
| *Memory Battery Fail | GUIDE 23 |
| *CMOS Checksum Fail | GUIDE 23 |
| *Interrupt Controller #1 Fail | GUIDE 23 |
| *Interrupt Controller #2 Fail | GUIDE 23 |
| *Memory in Protected Mode Fail | GUIDE 23 |
| *Protected Mode Fail | GUIDE 23 |
| *Processor Exception Interrupts Fail | GUIDE 23 |
| *Sizing System Memory 640K Not Found | GUIDE 23 |
| *System Memory 640K Fail | GUIDE 23 |
| *Sizing Extended Memory 00384K Not Found | GUIDE 23 |
| *Communications Error with Host | GUIDE 24 |
| *Disk Error | GUIDE 25 |
| *Disk Full Error | GUIDE 25 |
| *Disk Invalid Error | GUIDE 25 |
| *Disk Not Inserted Error | GUIDE 25 |
| *"B" Drive Error Messages | GUIDE 26 |
| Printer Inoperative | GUIDE 27 |

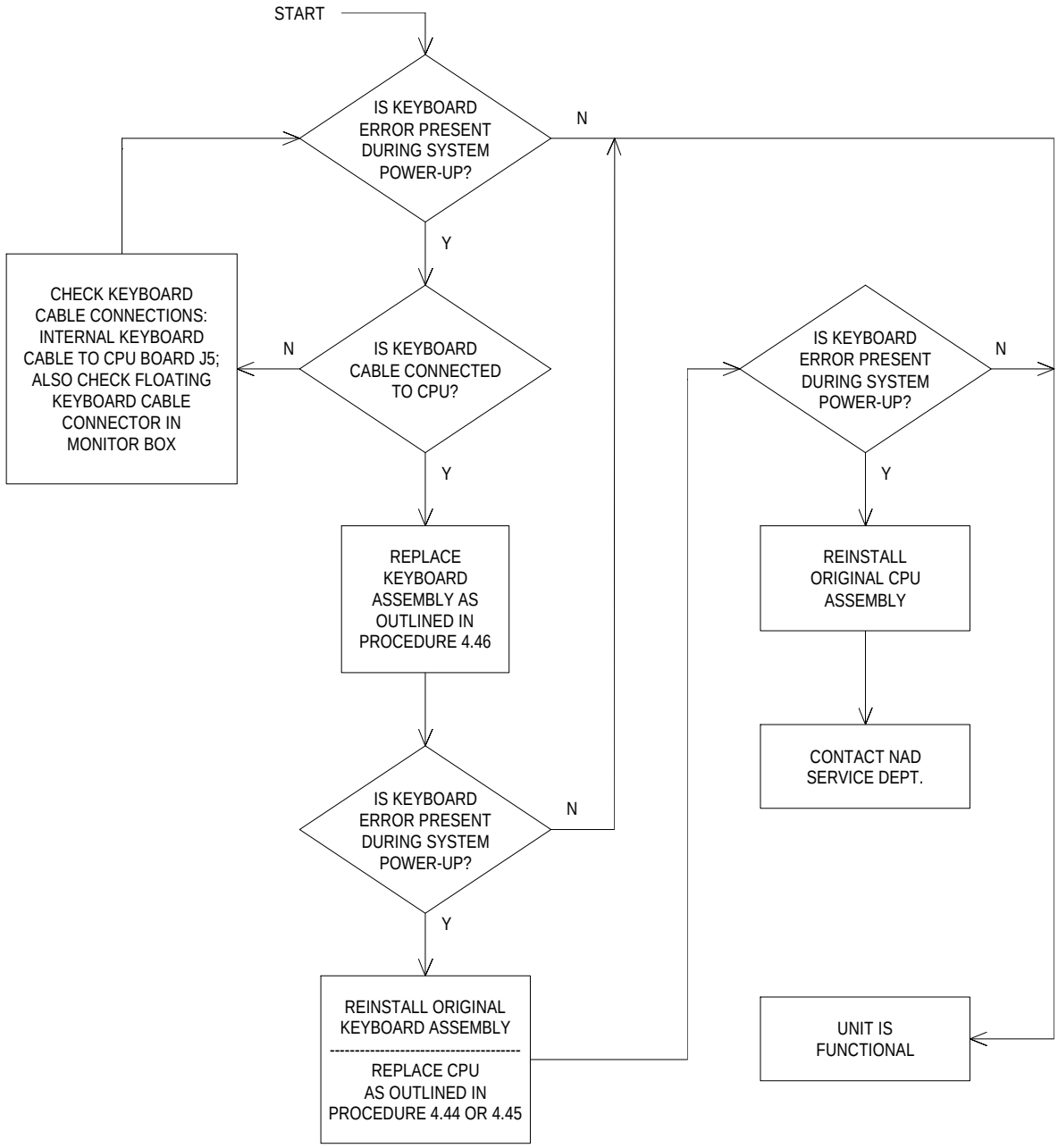
## GUIDE 21: Display Blank



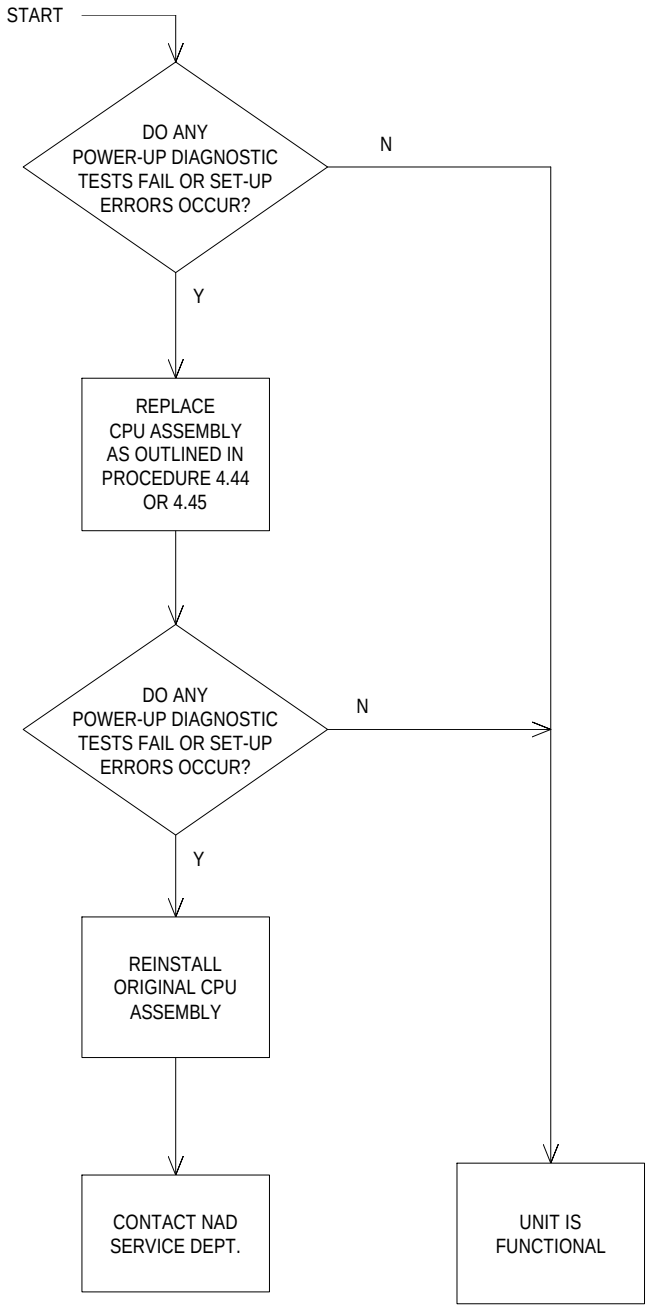
## GUIDE 21: Display Blank (continued)



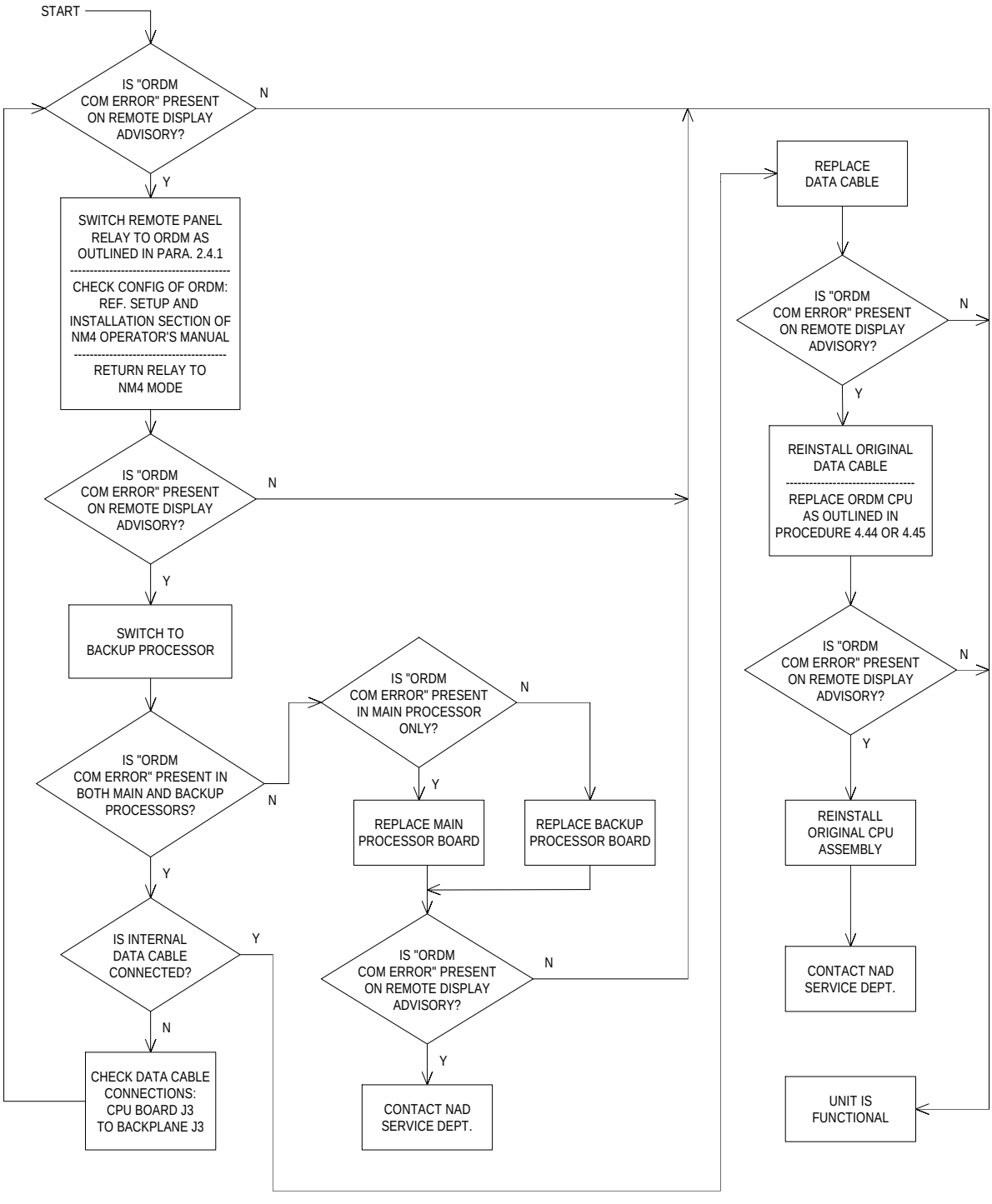
## GUIDE 22: Keyboard Error or Keyboard Not Present


START
IS KEYBOARD ERROR PRESENT DURING SYSTEM POWER-UP?
N
Y
CHECK KEYBOARD CABLE CONNECTIONS: INTERNAL KEYBOARD CABLE TO CPU BOARD J5; ALSO CHECK FLOATING KEYBOARD CABLE CONNECTOR IN MONITOR BOX
IS KEYBOARD CABLE CONNECTED TO CPU?
N
Y
REPLACE KEYBOARD ASSEMBLY AS OUTLINED IN PROCEDURE 4.46
IS KEYBOARD ERROR PRESENT DURING SYSTEM POWER-UP?
N
Y
REINSTALL ORIGINAL KEYBOARD ASSEMBLY
REPLACE CPU AS OUTLINED IN PROCEDURE 4.44 OR 4.45
IS KEYBOARD ERROR PRESENT DURING SYSTEM POWER-UP?
N
Y
REINSTALL ORIGINAL CPU ASSEMBLY
CONTACT NAD SERVICE DEPT.
UNIT IS FUNCTIONAL

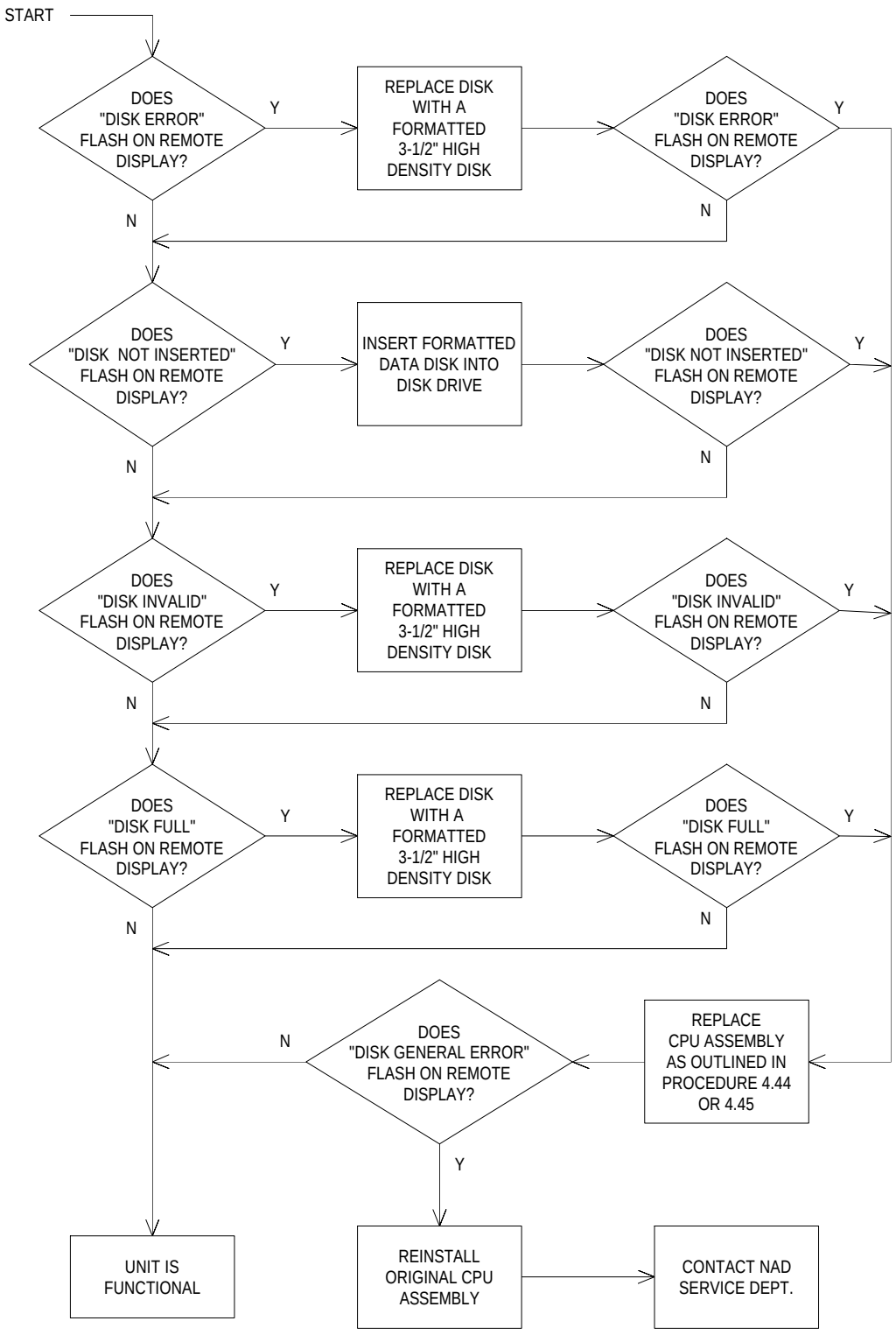
## GUIDE 23: Internal Diagnostic, Interrupt Controller, or Memory Failure


START
DO ANY POWER-UP DIAGNOSTIC TESTS FAIL OR SET-UP ERRORS OCCUR?
N
Y
REPLACE CPU ASSEMBLY AS OUTLINED IN PROCEDURE 4.44 OR 4.45
DO ANY POWER-UP DIAGNOSTIC TESTS FAIL OR SET-UP ERRORS OCCUR?
N
Y
REINSTALL ORIGINAL CPU ASSEMBLY
CONTACT NAD SERVICE DEPT.
UNIT IS FUNCTIONAL

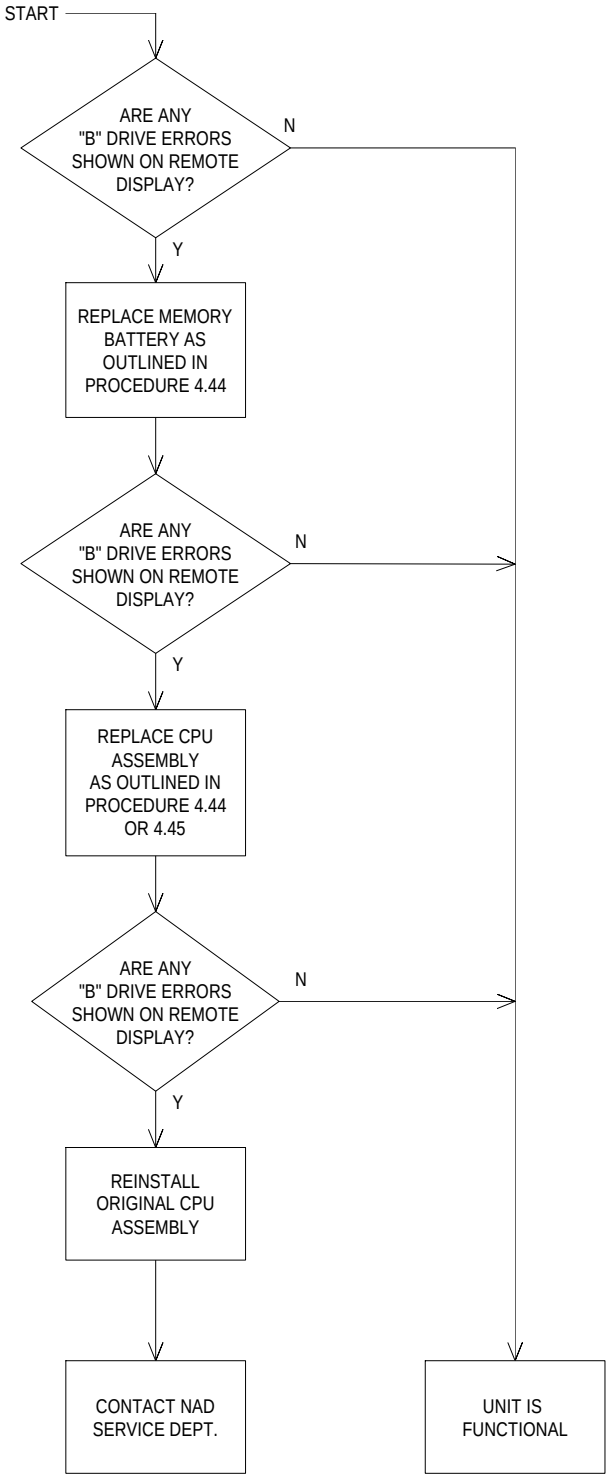
## GUIDE 24: Communications Error with Host


START
IS "ORDM COM ERROR" PRESENT ON REMOTE DISPLAY ADVISORY?
N
Y
SWITCH REMOTE PANEL RELAY TO ORDM AS OUTLINED IN PARA. 2.4.1
CHECK CONFIG OF ORDM: REF. SETUP AND INSTALLATION SECTION OF NM4 OPERATOR'S MANUAL
RETURN RELAY TO NM4 MODE
IS "ORDM COM ERROR" PRESENT ON REMOTE DISPLAY ADVISORY?
N
Y
SWITCH TO BACKUP PROCESSOR
IS "ORDM COM ERROR" PRESENT IN BOTH MAIN AND BACKUP PROCESSORS?
N
Y
IS "ORDM COM ERROR" PRESENT IN MAIN PROCESSOR ONLY?
N
Y
REPLACE MAIN PROCESSOR BOARD
REPLACE BACKUP PROCESSOR BOARD
IS INTERNAL DATA CABLE CONNECTED?
Y
N
IS "ORDM COM ERROR" PRESENT ON REMOTE DISPLAY ADVISORY?
N
Y
CHECK DATA CABLE CONNECTIONS: CPU BOARD J3 TO BACKPLANE J3
CONTACT NAD SERVICE DEPT.
REPLACE DATA CABLE
IS "ORDM COM ERROR" PRESENT ON REMOTE DISPLAY ADVISORY?
N
Y
REINSTALL ORIGINAL DATA CABLE
REPLACE ORDM CPU AS OUTLINED IN PROCEDURE 4.44 OR 4.45
IS "ORDM COM ERROR" PRESENT ON REMOTE DISPLAY ADVISORY?
N
Y
REINSTALL ORIGINAL CPU ASSEMBLY
CONTACT NAD SERVICE DEPT.
UNIT IS FUNCTIONAL

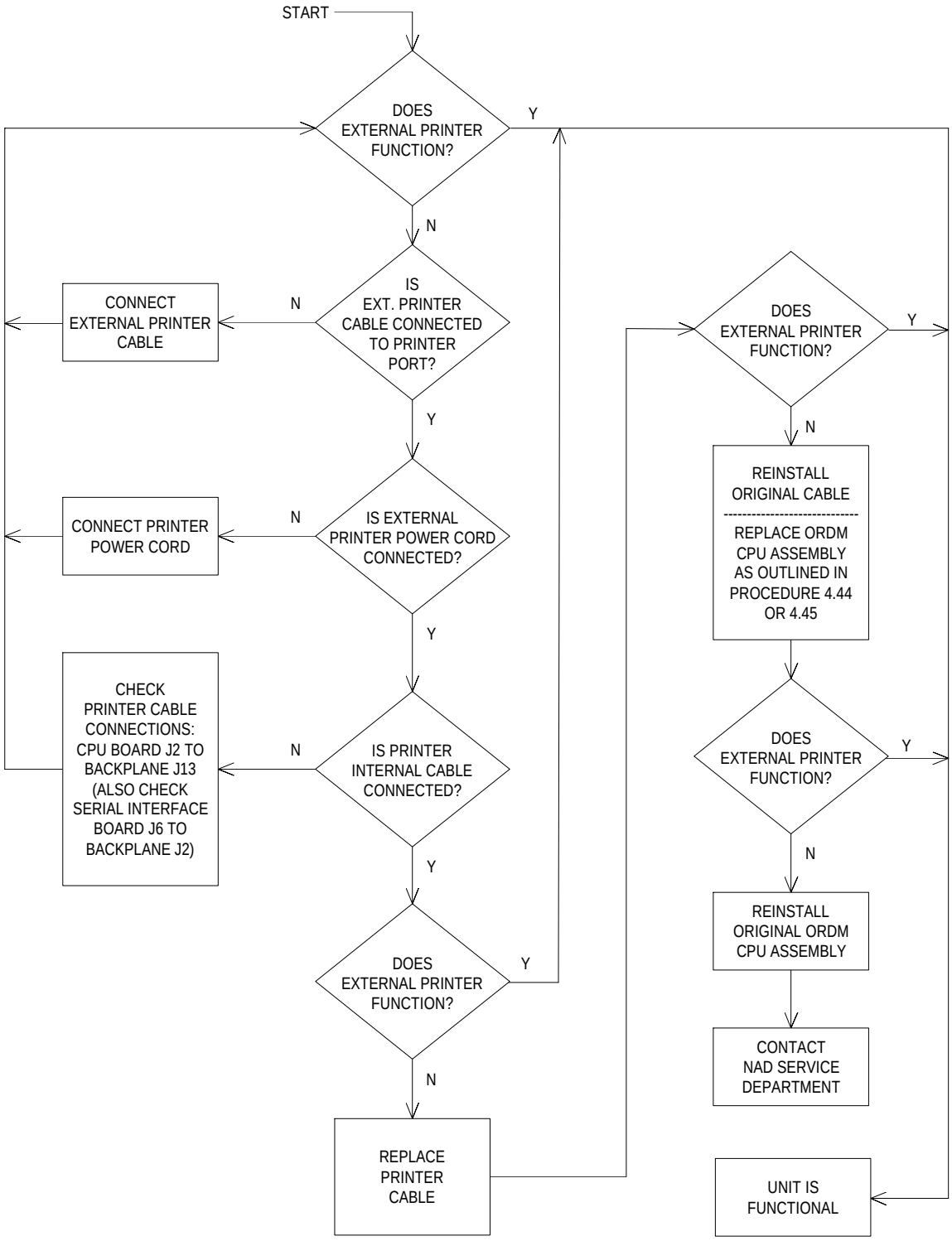
## GUIDE 25: Disk Errors



## GUIDE 26: "B" Drive Error Messages


START
ARE ANY "B" DRIVE ERRORS SHOWN ON REMOTE DISPLAY?
N
Y
REPLACE MEMORY BATTERY AS OUTLINED IN PROCEDURE 4.44
ARE ANY "B" DRIVE ERRORS SHOWN ON REMOTE DISPLAY?
N
Y
REPLACE CPU ASSEMBLY AS OUTLINED IN PROCEDURE 4.44 OR 4.45
ARE ANY "B" DRIVE ERRORS SHOWN ON REMOTE DISPLAY?
N
Y
REINSTALL ORIGINAL CPU ASSEMBLY
CONTACT NAD SERVICE DEPT.
UNIT IS FUNCTIONAL

## GUIDE 27: Printer Inoperative



RETURN TO THIS MANUAL'S TABLE OF CONTENTS
RETURN TO CD-ROM TABLE OF CONTENTS

# 4.0 REPLACEMENT PROCEDURES

This section outlines removal and replacement procedures for the field-replaceable assemblies of the NARKOMED 4 Anesthesia System.

These procedures are to be performed only by a Draeger Medical, Inc. qualified Technical Service Representative (TSR).

The following are the only procedures authorized by Draeger Medical, Inc. to be performed in the field. All other service procedures shall be referred to Draeger Medical, Inc.'s Technical Service Department.

**NOTE:** **The PMS PROCEDURE given in Section 6 must be performed after any replacement, removal, calibration or adjustment procedure.**

## 4.1 Cylinder Yoke Assemblies

Each cylinder yoke contains a replaceable filter and check valve assembly. Replacement of this assembly requires that the yoke be removed from the anesthesia machine. Figure 4-1 shows a typical cylinder yoke mounting arrangement. Access to the yoke mounting screws and gas line connection requires that the table top be removed from the machine.

4.1.1 Disconnect all pipeline hoses and set the System Power switch to ON.

4.1.2 Close all cylinder valves except the $O_2$ valve.

4.1.3 Set the oxygen flow to 5 liters per min.

4.1.4 Open the other gas flow control valves to drain pressure from the system.

4.1.5 Close the $O_2$ cylinder valve, and close the flow control valves. Press the $O_2$ Flush valve to drain oxygen pressure from the system.

4.1.6 Set the System Power switch to STANDBY.

4.1.7 Remove the cylinder where the yoke is to be replaced.

WARNING: Store the cylinder in a safe place and lay it on its side.

4.1.8 Remove the screws holding the table top to the machine and lift out the table top.

4.1.9 Pull the writing or keyboard tray out to its fully extended position.

4.1.10 Disconnect the gas line fitting at the yoke and remove the two yoke mounting screws.

4.1.11 Remove the filter and check valve assembly from the yoke and install a replacement assembly.

If the entire yoke assembly is being replaced, verify that the pin indexing arrangement and the label are in agreement with the gas designation stamped on the mounting surface of the yoke. Refer to the parts list in Section 8.

NOTE: If the yoke spacer is removed from the frame rail of the machine, be sure to re-install it in its original position.

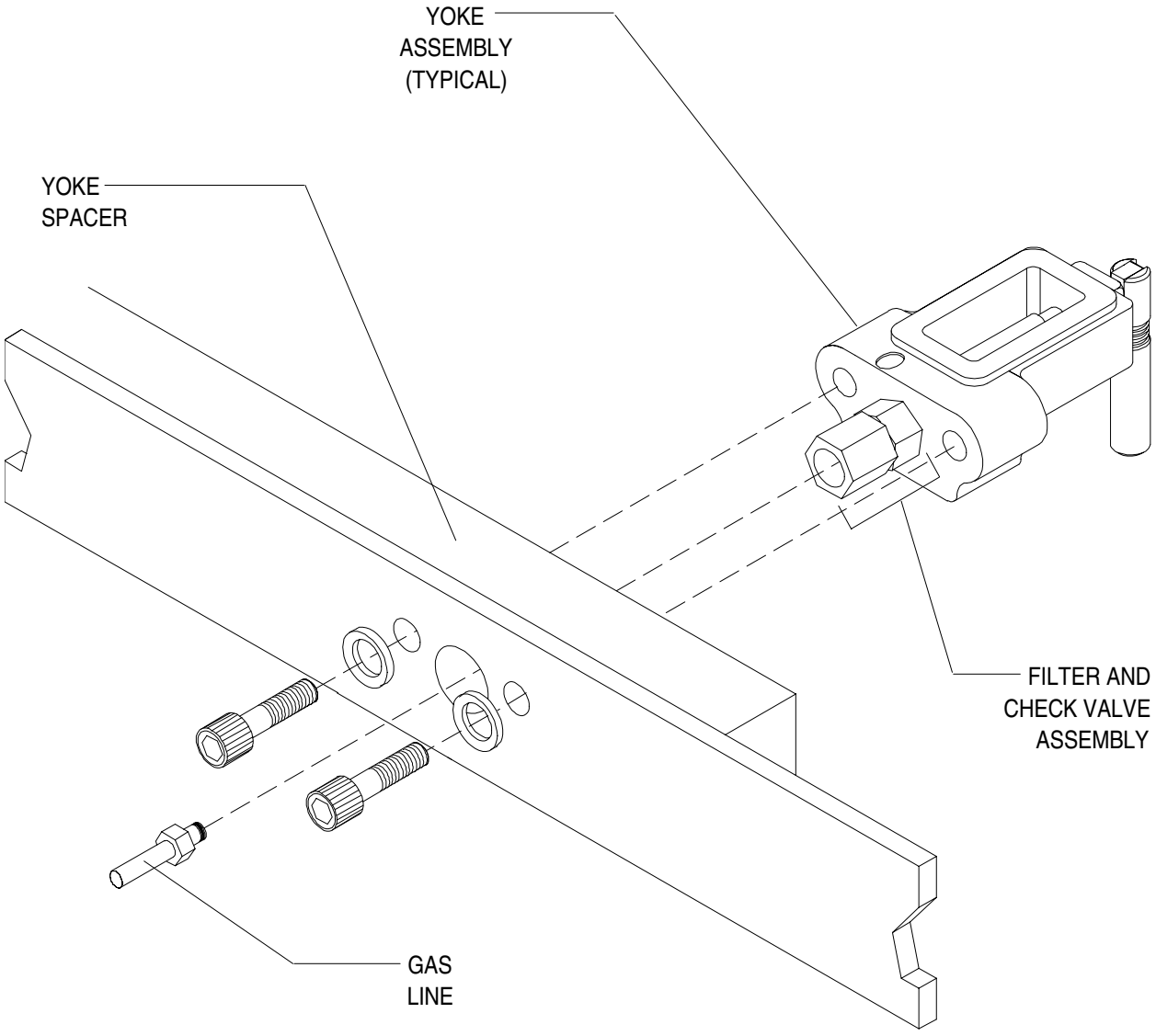



**Figure 4-1: CYLINDER YOKE ASSEMBLY**

4.1.12 Position the yoke on the spacer, and install the two mounting screws and lockwashers. Tighten the screws securely. Connect the gas line fitting to the yoke.

4.1.13 If a new cylinder is being installed, remove the old sealing washer from the gas inlet of the yoke and install a new washer.

4.1.14 Install the correct cylinder in the yoke, making sure that the index pins are properly engaged before tightening the handle bolt. The cylinder should hang vertically after the handle is tight.

4.1.15 Perform the following leak test on the yoke assembly:

4.1.15.1 Open the cylinder valve and check for a pressure indication on the corresponding gauge at the gas instrumentation panel.

NOTE: The cylinder used for this test must contain the following minimum pressure at 70°F (21°C):

$O_2$ : 1000 Psi
$N_2O$ : 600 Psi
$O_2$+He : 1000 Psi
$CO_2$ : 600 Psi
AIR : 1000 Psi

4.1.15.2 Close the cylinder valve and remove the cylinder from the yoke.

4.1.15.3 For any gas, the pressure should not drop more than 50 Psi in two minutes.

4.1.16 Re-install the cylinder in the yoke.

4.1.17 Replace the table top and its retaining screws.

4.1.18 Replace the pipeline hoses.

4.1.19 Perform the PMS Procedure given in Section 6.

## 4.2 Cylinder Pressure Regulators

Access to the cylinder pressure regulators requires that the table top be removed from the anesthesia machine. Figure 4-2 shows the mounting arrangement of the regulators and typical connections.

4.2.1 Disconnect all pipeline hoses and set the System Power switch to ON.

4.2.2 Close all cylinder valves except the $O_2$ valve.

4.2.3 Set the oxygen flow to 5 liters per min.

4.2.4 Open the other gas flow control valves to drain pressure from the system.

4.2.5 Close the $O_2$ cylinder valve, and close the flow control valves. Press the $O_2$ Flush valve to drain oxygen pressure from the system.

4.2.6 Set the System Power switch to STANDBY.

4.2.7 Remove the cylinder corresponding to the regulator to be replaced.

4.2.8 Remove the screws holding the table top to the machine and lift out the table top.

4.2.9 Remove the top drawer from the cabinet and pull the writing or keyboard tray out to its fully extended position.

4.2.10 Disconnect the three compression fittings at the regulator.

4.2.11 Loosen the two setscrews holding the regulator to its mounting bracket and remove the regulator.

4.2.12 Record the serial number of the regulator that was removed, and record the serial number of the replacement regulator.

NOTE: If fittings must be installed in the replacement regulator, use Loctite #271 (red). Refer to the parts list in Section 8.

NOTE: For Canadian machines, verify that the correct relief valve is installed in the regulator. Refer to the parts list in Section 8 for CSA items.

4.2.13 Position the replacement regulator in its mounting bracket, and connect the three compression fittings. Do not tighten the fittings yet.

TOP VIEW OF NARKOMED 4
WITH TABLE TOP REMOVED

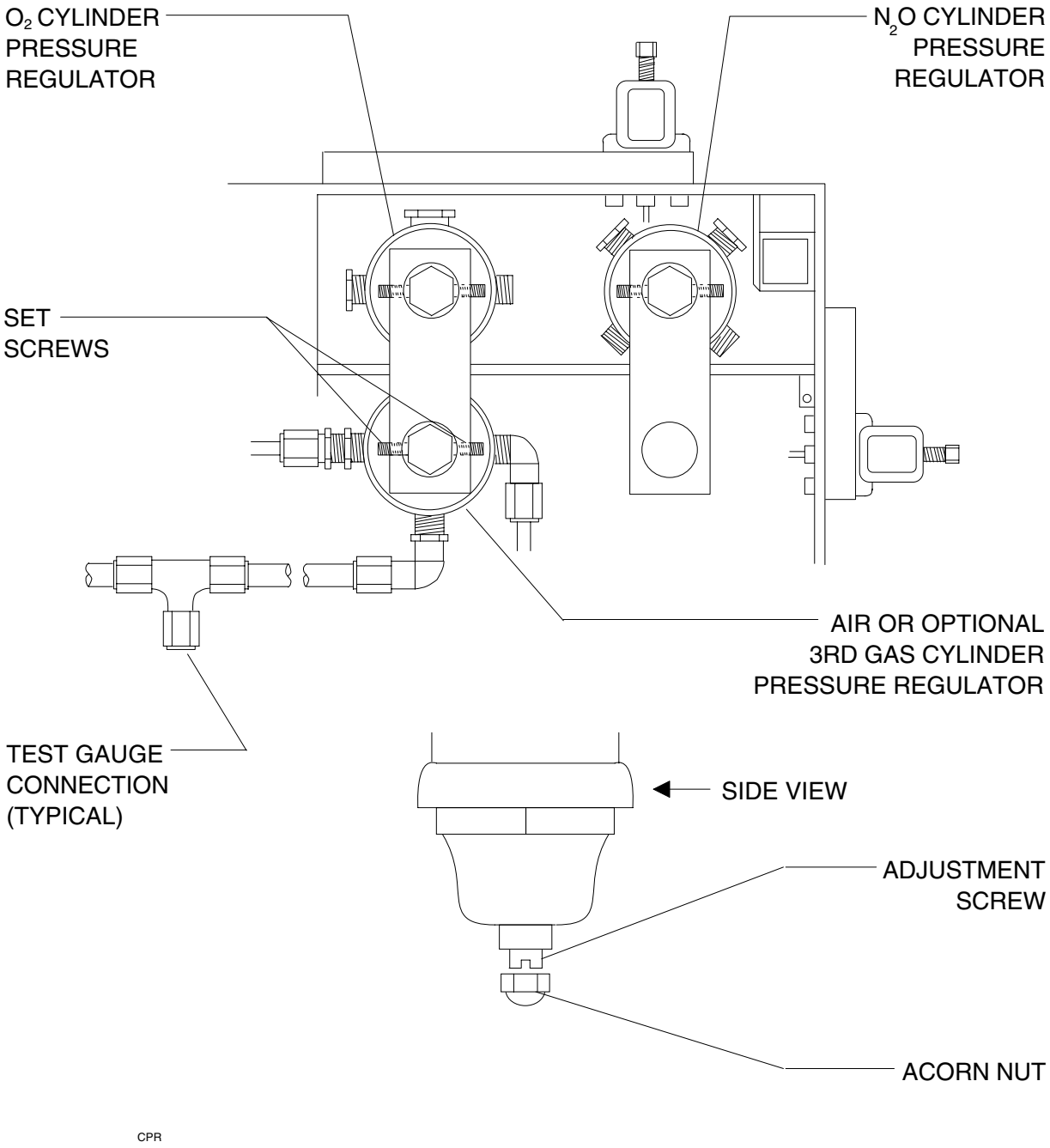



**Figure 4-2: CYLINDER PRESSURE REGULATORS**

4.2.14 Tighten the regulator mounting setscrews to a torque of 50 to 55 in. lbs.

4.2.15 Tighten the compression fittings.

4.2.16 Locate the TEE fitting in the ¼ in. diameter regulator output line, and remove the plug from the TEE fitting.

4.2.17 Set the regulator output pressure in accordance with the Cylinder Pressure Regulator Adjustment given in Section 5.

4.2.18 Perform the following leak test on the high pressure side of the regulator:

4.2.18.1 Open the cylinder valve and check for a pressure indication on the corresponding gauge at the gas instrumentation panel.

NOTE: The cylinder used for this test must contain the following minimum pressure at 70°F (21°C):

$O_2$ : 1000 Psi
$N_2O$ : 600 Psi
$O_2$+He : 1000 Psi
$CO_2$ : 600 Psi
AIR : 1000 Psi

4.2.18.2 Close the cylinder valve and remove the cylinder from the yoke.

4.2.18.3 For any gas, the pressure should not drop more than 50 Psi in two minutes.

4.2.19 Re-install the cylinder in the yoke.

4.2.20 Replace the table top and its retaining screws.

4.2.21 Replace the top drawer in the cabinet.

4.2.22 Connect the pipeline hoses.

4.2.23 Perform the PMS Procedure given in Section 6.

## 4.3 Cylinder Cutoff Valves (Canada)

Access to the cylinder cutoff valves requires removal of the table top from the anesthesia machine. Figure 4-3 shows the locations of the $O_2$, Air or 3rd gas, and $N_2O$ cutoff valve assemblies. The instructions apply to all three assemblies. On earlier machines the tubing arrangement may be slightly different from that illustrated.

**NOTE:** Replacement of the $O_2$ Cutoff Valve Assembly shall be performed every 24 months. Documentation shall be created by the service person and a copy distributed to the owner institution. Testing of the $O_2$ Cutoff Valve shall be performed at each PMS. (Perform the flow test given at the end of the following procedure)

4.3.1 Disconnect all pipeline hoses and set the System Power switch to ON.

4.3.2 Close all cylinder valves except the $O_2$ valve.

4.3.3 Set the oxygen flow to 5 liters per min.

4.3.4 Open the other gas flow control valves to drain pressure from the system.

4.3.5 Close the $O_2$ cylinder valve, and close the flow control valves. Press the $O_2$ Flush valve to drain oxygen pressure from the system.

4.3.6 Set the System Power switch to STANDBY.

4.3.7 Remove the screws holding the table top to the machine and lift out the table top.

4.3.8 Remove the top drawer from the cabinet and pull the writing or keyboard tray out to its fully extended position.

4.3.9 Disconnect the compression fittings indicated at points marked C on the illustration.

4.3.10 Cut the tie-wrap clamp and disconnect the flexible tubing from the cutoff valve assembly at the point marked A on the illustration.

NOTE: On later machines with assemblies that have brass fittings instead of nylon, the flex tubing is attached with a press-on hose clamp instead of a tie strap.

4.3.11 Remove the cylinder cutoff assembly.

4.3.12 Connect the flexible tubing to the replacement cutoff valve assembly and secure it with a new tie-wrap clamp.

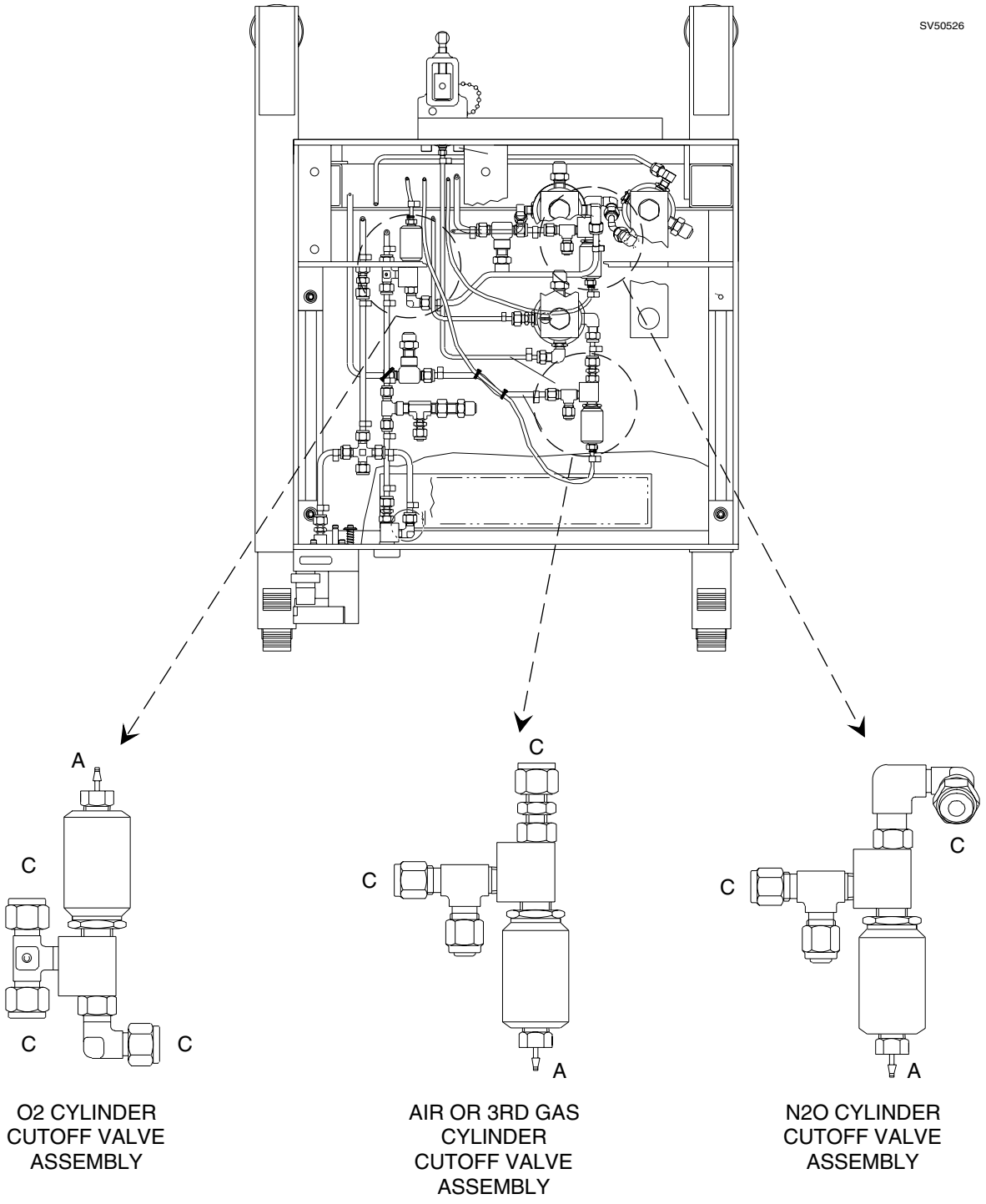



**Figure 4-3: CYLINDER CUTOFF VALVES (CANADA)**

4.3.13 Connect and tighten the compression fittings at points marked C on the illustration.

4.3.14 Perform the following test: --Remove the plug from the test gauge connection at the Tee fitting in the regulator outlet piping, and install a test gauge.

NOTE: The cylinders used for this test must contain the following minimum pressure: $O_2$ : 1000 PSI AIR : 1000 PSI
$O_2$+He : 1000 PSI $N_2O$ : 745 PSI

--Set the System Power switch to ON.
--For the $O_2$ cutoff valve: open the $O_2$ cylinder valve and set the oxygen flow to 4 liters per min.
--For the $N_2O$ cutoff valve: open the $O_2$ cylinder valve and the $N_2O$ cylinder valve. Set each flow to 4 liters per min.
--Verify that regulator outlet pressure is between 43 and 49 PSI.
--Connect the pipeline hoses and pressurize to 50 PSI.
--Turn off the pipeline supply and observe the pipeline pressure gauge.
--The cutoff valve shall open when the pipeline pressure drops through the range of 45 to 40 PSI.
--Close the cylinder valve(s), and close the flow control valve(s).
--Disconnect test pressure gauge and reinstall the plug in the regulator outlet piping.

4.3.15 Replace the table top and its retaining screws.

4.3.16 Replace the top drawer in the cabinet.

4.3.17 Connect the pipeline hoses.

4.3.18 Perform the PMS Procedure given in Section 6.

$O_2$ Flow Test:

--Disconnect all pipeline supplies.
--Install a full $O_2$ cylinder on the machine, and open the cylinder valve.
--Turn the System Power switch to ON.
--Set the Inspiratory Flow control to maximum high, and turn the ventilator switch to ON.
--Set the oxygen flow to 10 l/min.
--Verify that the oxygen flow does not drop below 8 l/min. while the ventilator is running.
--Press and hold the $O_2$ FLUSH button while observing the $O_2$ flowmeter, and verify that the oxygen flow does not drop below 8 l/min.
--If the oxygen flow in either of the above two steps drops below 8 l/min., replace the $O_2$ cutoff valve assembly.

## 4.4 Cylinder and Pipeline Pressure Gauges

Replacement of the cylinder and pipeline pressure gauges requires that the plexiglass front cover be removed from the gas instrumentation panel, and also the rear cover for access to the gauge connections. Figure 4-4 shows disassembly and mounting details.

4.4.1 Disconnect all pipeline hoses and set the System Power switch to ON.

4.4.2 Close all cylinder valves except the $O_2$ valve.

4.4.3 Set the oxygen flow to 5 liters per min.

4.4.4 Open the other gas flow control valves to drain pressure from the system.

4.4.5 Close the $O_2$ cylinder valve, and close the flow control valves. Press the $O_2$ Flush valve to drain oxygen pressure from the system.

4.4.6 Set the System Power switch to STANDBY.

4.4.7 Remove the screws holding the rear cover, and remove the cover.

4.4.8 Remove the screws holding the table top to the machine and lift out the table top.

4.4.9A Early models: Remove the two screws (from the back) holding the front plate at the top of the plexiglass cover. Hold the front plate as the screws are removed from the back.

4.4.9B Later models (without the $O_2/N_2O$ ratio alarm lamp): Remove the six screws holding the flowmeter shield and vapor box cover panel, and remove the panel.

4.4.10 Remove the flow control knobs. Each knob has two setscrews.

NOTE: If a knob must be rotated to allow access to a setscrew, carefully note its position so that it can be re-assembled in the same position with the "Off Stop" properly set.

4.4.11 Remove the two screws holding the knob guard in place, and remove the knob guard.

4.4.12 Remove the three screws holding the plexiglass cover over the flow tubes and gauges, and carefully remove the cover.

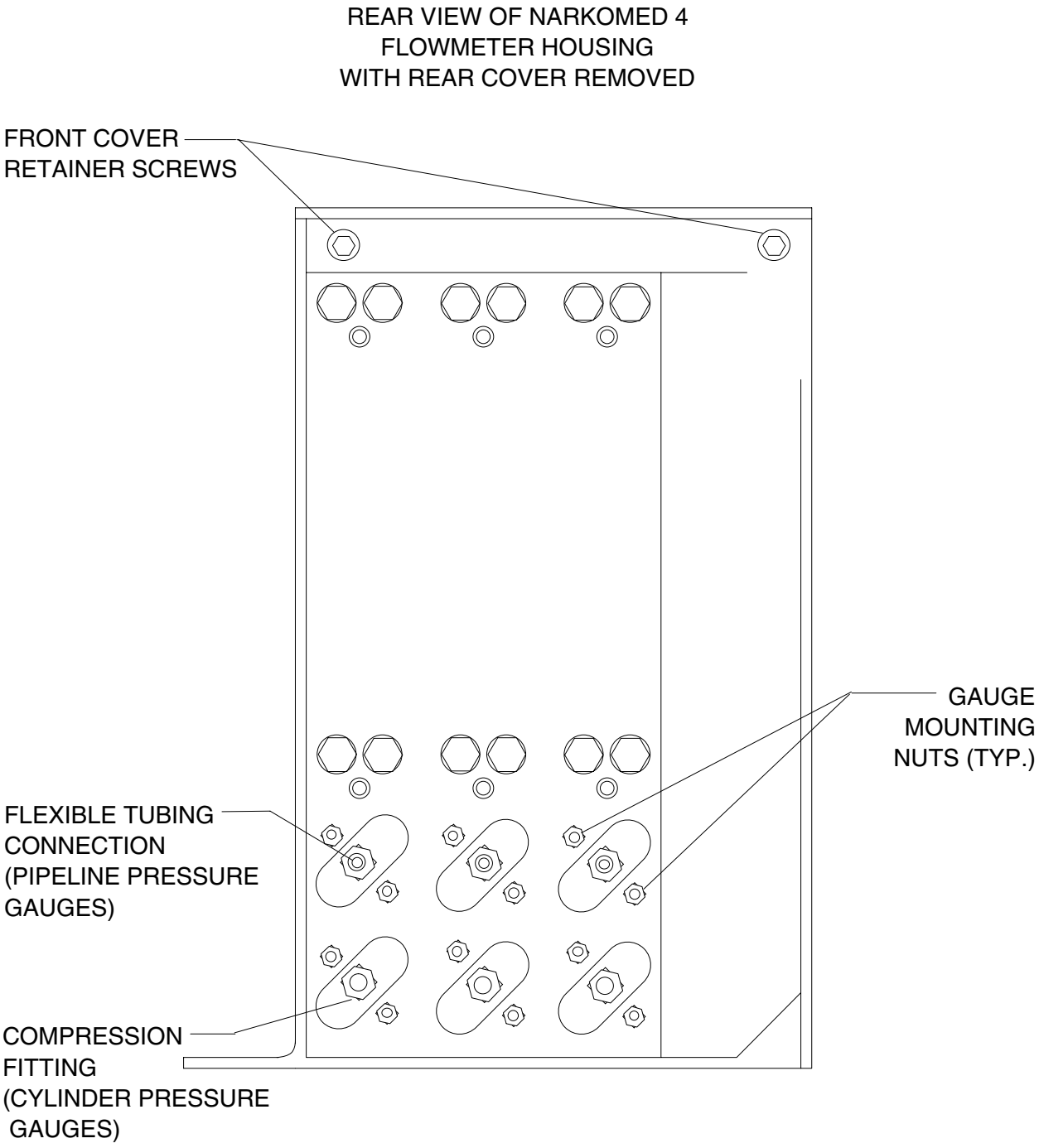



**Figure 4-4: CYLINDER AND PIPELINE PRESSURE GAUGES**

NOTE: Intermediate assemblies may need to be removed to allow access to the gauge connections and mounting hardware. Be sure to keep a record of the disassembly sequence so that all tubing can be correctly re-assembled.

4.4.13A For the cylinder pressure gauges:

Disconnect the compression fitting at the back of the gauge.

Remove the gauge mounting nuts, and remove the gauge from the front of the panel.

Install the replacement gauge in the panel using the flat washers, lock washers and mounting nuts that were previously removed.

Connect the gas line to the gauge and tighten the compression fitting.

4.3.13B For the pipeline pressure gauges:

Locate the flexible tubing connecting the gauge to the pipeline inlet assembly, cut the tie-wrap tubing clamp at the pipeline inlet and disconnect the tubing.

NOTE: On later machines that have brass fittings instead of nylon, the flex tubing is attached with a press-on hose clamp instead of a tie strap.

Remove the gauge mounting nuts, and remove the gauge from the front of the panel.

Cut the tie-wrap tubing clamp and disconnect the flexible tubing from the gauge.

Connect a new 7-inch length of tubing (8-inch for the air pipeline pressure gauge) to the replacement gauge and secure it with a new tie-wrap clamp.

Place the gauge in the panel and secure it with the flat washers, lock washers and mounting nuts that were previously removed.

Connect the other end of the flexible tubing to the pipeline inlet assembly and secure it with a tie-wrap clamp.

4.4.14 If a cylinder pressure gauge was replaced, perform the following leak test:

4.4.14.1 Open the cylinder valve and check for a pressure indication on the corresponding gauge at the gas instrumentation panel.

NOTE: The cylinder used for this test must contain the following minimum pressure at 70°F (21°C):

$O_2$ : 1000 Psi
$N_2O$ : 600 Psi
$O_2$+He : 1000 Psi
$CO_2$ : 600 Psi
AIR : 1000 Psi

4.4.14.2 Close the cylinder valve and remove the cylinder from the yoke.

4.4.14.3 For any gas, the pressure should not drop more than 50 Psi in two minutes.

4.4.15 Re-install the cylinder in the yoke.

4.4.16 Place the plexiglass cover over the gauges and flow tubes, and install the three screws near the top of the cover. Do not over-tighten these screws as the plexiglass may crack.

4.4.17 Place the knob guard over the flow control valves and install its two retaining screws.

4.4.18 Install the flow control knobs and tighten their setscrews. If the knobs are installed properly, their labels will be straight when the knobs are against their clockwise stops.

4.4.19 Replace the front plate at the top of the plexiglass cover and secure it with the hardware that was previously removed.

4.4.20 Replace the rear cover and its retaining screws.

4.4.21 Replace the table top and its retaining screws.

4.4.22 Connect the pipeline hoses.

4.4.23 Perform the PMS Procedure given in Section 6.

## 4.5 Flowmeters

The flowmeter tubes are held by compression in gaskets at the top and bottom of each tube. Each upper gasket is seated in an adjustable retainer that allows removal of the tube as shown in Figure 4-5. Access to the flow tubes and their retainers requires removal of the plexiglass cover on the gas instrumentation panel.

4.5.1 Disconnect all pipeline hoses and set the System Power switch to ON.

4.5.2 Close all cylinder valves except the $O_2$ valve.

4.5.3 Set the oxygen flow to 5 liters per min.

4.5.4 Open the other gas flow control valves to drain pressure from the system.

4.5.5 Close the $O_2$ cylinder valve, and close the flow control valves. Press the $O_2$ Flush valve to drain oxygen pressure from the system.

4.5.6 Set the System Power switch to STANDBY.

4.5.7 Remove the screws holding the table top to the machine and lift out the table top.

4.5.8 Early models: Remove the rear flowmeter housing cover.

4.5.9A Early models: Remove the two screws (from the back) holding the front plate at the top of the plexiglass cover. Hold the front plate as the screws are removed from the back.

4.5.9B Later models (without the $O_2/N_2O$ ratio alarm lamp): Remove the six screws holding the flowmeter shield and vapor box cover panel, and remove the panel.

4.5.10 Remove the flow control knobs. Each knob has two setscrews.

NOTE: If a knob must be rotated to allow access to a setscrew, carefully note its position so that it can be re-assembled in the same position with the "Off Stop" properly set.

4.5.11 Remove the two screws holding the knob guard in place, and remove the knob guard.

4.5.12 Remove the three screws holding the plexiglass cover over the flow tubes and gauges, and carefully remove the cover.

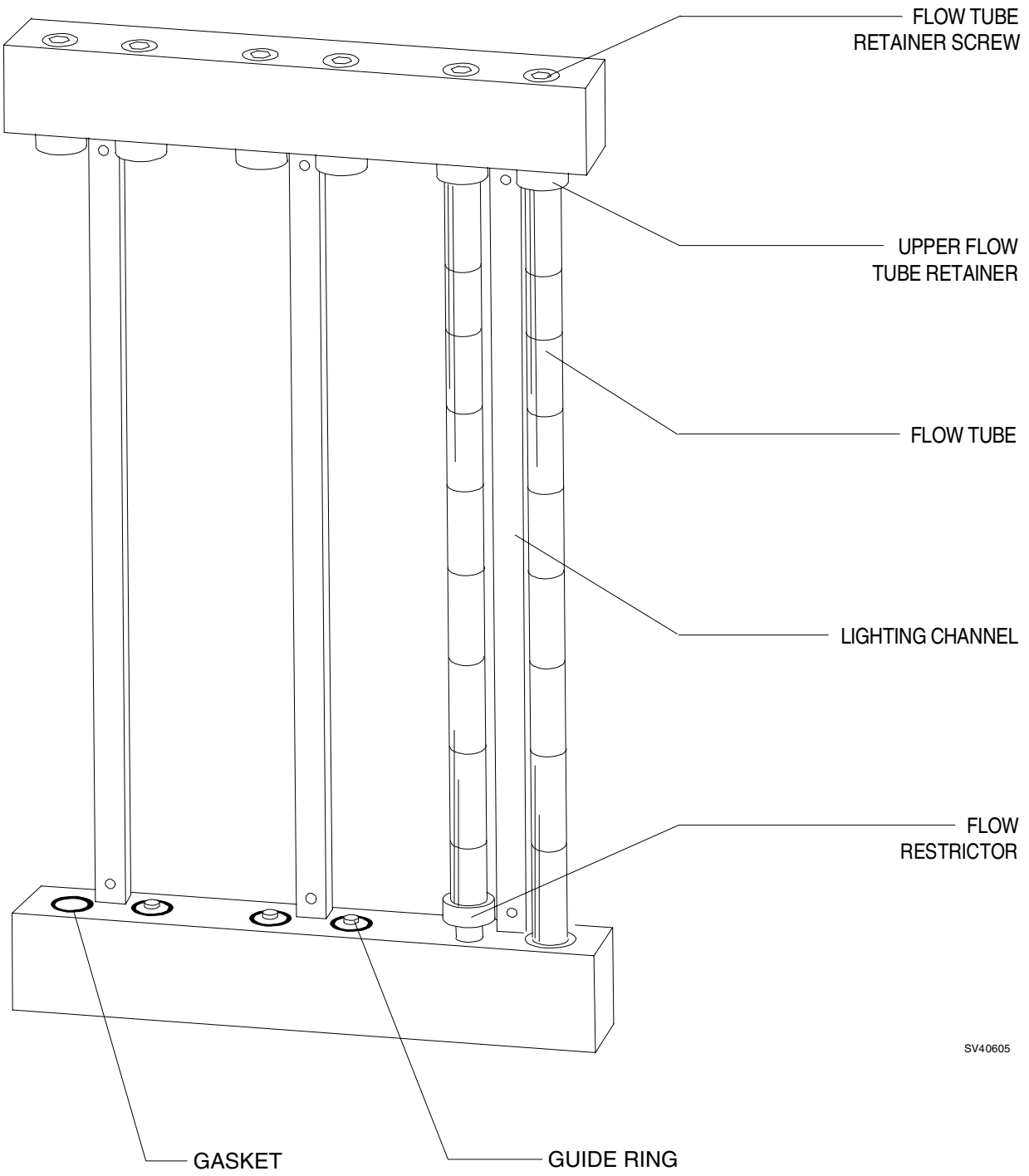



**Figure 4-5: FLOWMETERS**

4.5.13 Loosen the screw directly above the flowmeter tube to be replaced. Turning the screw counter clockwise will raise the upper flow tube retainer. Raise the retainer far enough to be able to pull the top of the tube outward, and remove the tube.

NOTE: If the bottom of the tube is seated in a flow restrictor, be sure that the arrangement of the restrictor and its gaskets is not disturbed.

4.5.14 Make sure that the replacement flow tube bears the correct markings and has a ball.

4.5.15 Place the bottom of the flowmeter tube into the guide ring of the lower gasket seal, and position the top of the flow tube into the center guide ring of the top gasket seal. It will be easier to hold the tube if the adjacent lighting channel is pulled forward and temporarily removed.

CAUTION: The flowmeter tube must be properly centered over the guide rings or damage to the flowmeter tube may occur.

4.5.16 Ensure that the markings on the flow tube are facing forward, and turn the upper retainer screw clockwise until the flow tube is firmly held in place.

CAUTION: Do not over-tighten the screw as the flowmeter tube may break.

4.5.17 Perform the following leak test on the system:

4.5.17.1 Disconnect the absorber hose from the freshgas outlet.

4.5.17.2 Connect a test gauge and B.P. bulb to the freshgas outlet, and pressurize the system to 50 cm $H_2O$.

4.5.17.3 The pressure should not drop more than 10 cm $H_2O$ in thirty seconds.

4.5.18 Disconnect the test gauge and re-connect the absorber hose to the freshgas outlet.

4.5.19 Replace any lighting channels that were previously removed.

4.5.20 Place the plexiglass cover over the gauges and flow tubes, and install the three screws near the top of the cover. Do not over-tighten these screws as the plexiglass may crack.

4.5.21 Place the knob guard over the flow control valves and install its two retaining screws.

4.5.22 Install the flow control knobs and tighten their setscrews. If the knobs are installed properly, their labels will be straight when the knobs are against their clockwise stops.

4.5.23 Replace the front plate at the top of the plexiglass cover and secure it with the hardware that was previously removed.

4.5.24 If applicable, replace the rear flowmeter housing cover.

4.5.25 Replace the table top and its retaining screws.

4.5.26 Connect the pipeline hoses.

4.5.27 Perform the PMS Procedure given in Section 6.

## 4.6 Flow Control Valves

The flow control valves have replaceable elements that are removable from the front of the gas instrumentation panel as shown in Figure 4-6. Each flow control knob has a clockwise positive stop arrangement that prevents damage to the valve seat. Whenever a valve cartridge is replaced, the "off stop" must be set as outlined in the following procedure.

4.6.1 Disconnect all pipeline hoses and set the System Power switch to ON.

4.6.2 Close all cylinder valves except the $O_2$ valve.

4.6.3 Set the oxygen flow to 5 liters per min.

4.6.4 Open the other gas flow control valves to drain pressure from the system.

4.6.5 Close the $O_2$ cylinder valve and the $O_2$ flow control valve. Press the $O_2$ Flush valve to drain oxygen pressure from the system.

4.6.6 Set the System Power switch to STANDBY.

4.6.7 Remove the flow control knobs.

4.6.8 Remove the two screws holding the knob guard in place, and remove the knob guard.

4.6.9 Remove the stop pin nut.

4.6.10 Remove the flow control valve by holding it at the wrench flats and turning it counter-clockwise.

4.6.11 Install the replacement flow control valve in the valve body.

CAUTION: Before tightening the cartridge, rotate the valve shaft several turns counter-clockwise to prevent bottoming the valve element into the seat when the cartridge is tightened.

4.6.12 Replace the stop pin nut.

4.6.13 Replace the knob guard and secure it with the two mounting screws.

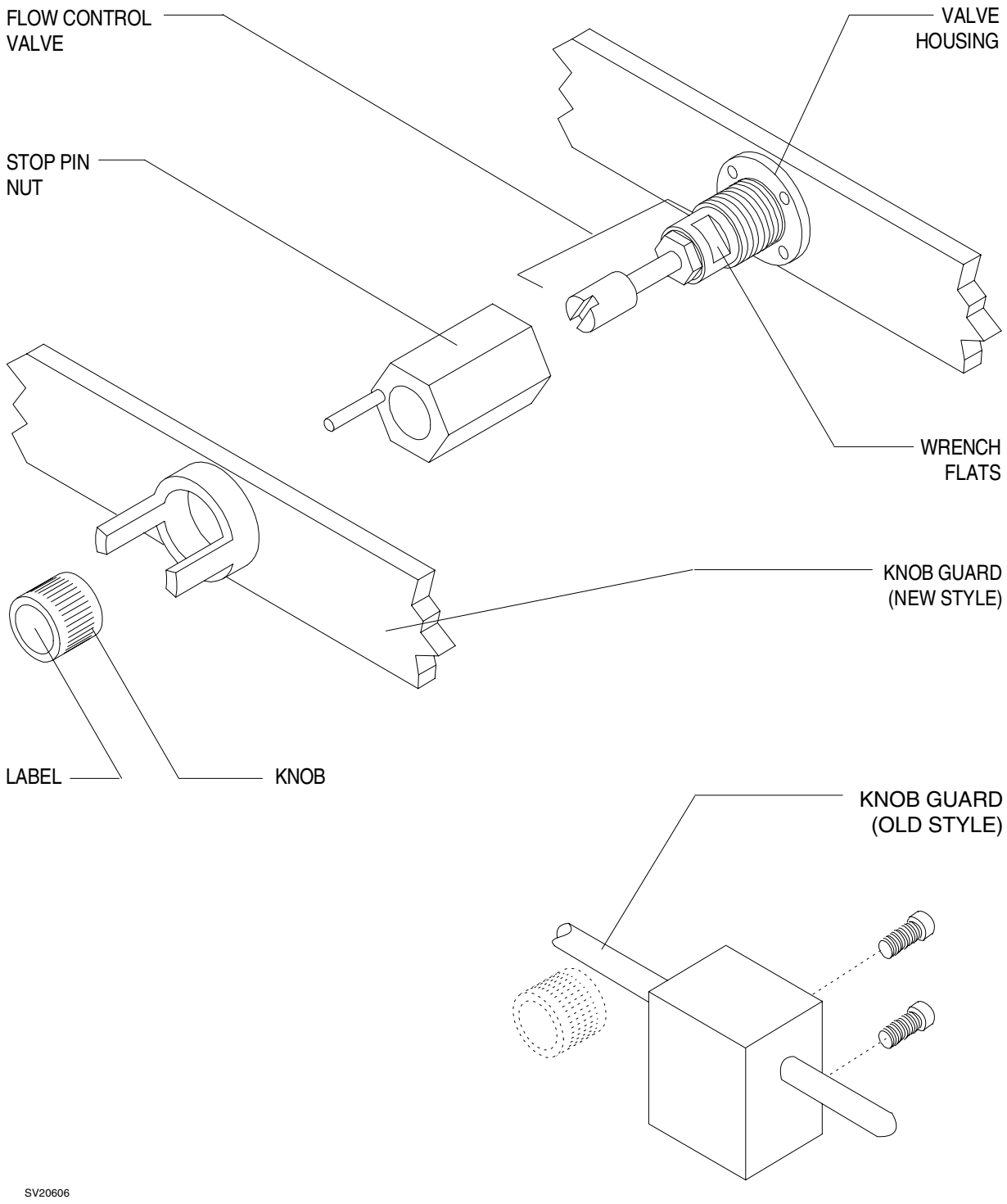



**Figure 4-6: FLOW CONTROL VALVES**

4.6.14 Set the System Power switch to ON.

4.6.15A For the $O_2$ flow control valve:

Open the oxygen cylinder valve.

Turn the flow control valve clockwise until the flow rate will not drop any further. (If the machine has been modified to eliminate the minimum flow feature, turn the valve until the flow rate is zero.)

4.6.15B For the other gas flow control valves:

Open the oxygen cylinder valve, and open the cylinder valve corresponding to the flow control valve replacement.

Set the oxygen flow rate to four liters per minute.

Turn the other gas flow control valve clockwise until the flow rate is zero.

4.6.16 Place the knob on the flow control valve shaft and turn it clockwise until it engages the stop pin. Tighten one of the knob setscrews.

4.6.17 Turn the knob in both directions and ensure that the flow can be controlled over its entire range. When the valve is closed, the knob should be against the clockwise stop. Tighten the remaining setscrew.

4.6.18 If the knob label is not horizontal when the valve is closed, remove the label and install a new label in the correct position.

4.6.19 Connect the pipeline hoses.

4.6.20 Perform the PMS Procedure given in Section 6.

## 4.7 Oxygen Supply Pressure Failure Protection Device

The oxygen supply failure protection devices (failsafe assemblies) are located behind the gas instrumentation panel. Access to these assemblies requires removal of the rear cover. For earlier machines, replacement assemblies are supplied with all hardware out to the first compression fitting in each line.

On later machines with flowmeter assemblies having an Oxygen Ratio Controller (ORC), failsafe assemblies have an additional inlet port that allows both pipeline and cylinder supplies to be connected directly to the failsafe assemblies. Figure 4-7 shows the arrangement for both types of assemblies.

4.7.1 Disconnect all pipeline hoses and set the System Power switch to ON.

4.7.2 Close all cylinder valves except the $O_2$ valve.

4.7.3 Set the oxygen flow to 5 liters per min.

4.7.4 Open the other gas flow control valves to drain pressure from the system.

4.7.5 Close the $O_2$ cylinder valve and the $O_2$ flow control valve. Press the $O_2$ Flush valve to drain oxygen pressure from the system.

4.7.6 Set the System Power switch to STANDBY.

4.7.7 Remove the screws holding the rear cover, and remove the cover.

4.7.8 Cut the tie-wrap clamp on the flexible $O_2$ control line, and disconnect the flexible tube.

NOTE: On later machines with assemblies that have brass fittings instead of nylon, the flex tubing is attached with a press-on hose clamp instead of a tie strap.

4.7.9 Disconnect the compression fittings at the side ports and at the check valve, and remove the assembly.

NOTE: If fittings must be installed in the replacement block assembly, use Loctite #271 (red). See parts list in Section 8.

4.7.10 Install the replacement failsafe assembly, and tighten all compression fittings.

4.7.11 Connect the flexible tubing to the control port, and install a new tie-wrap clamp.

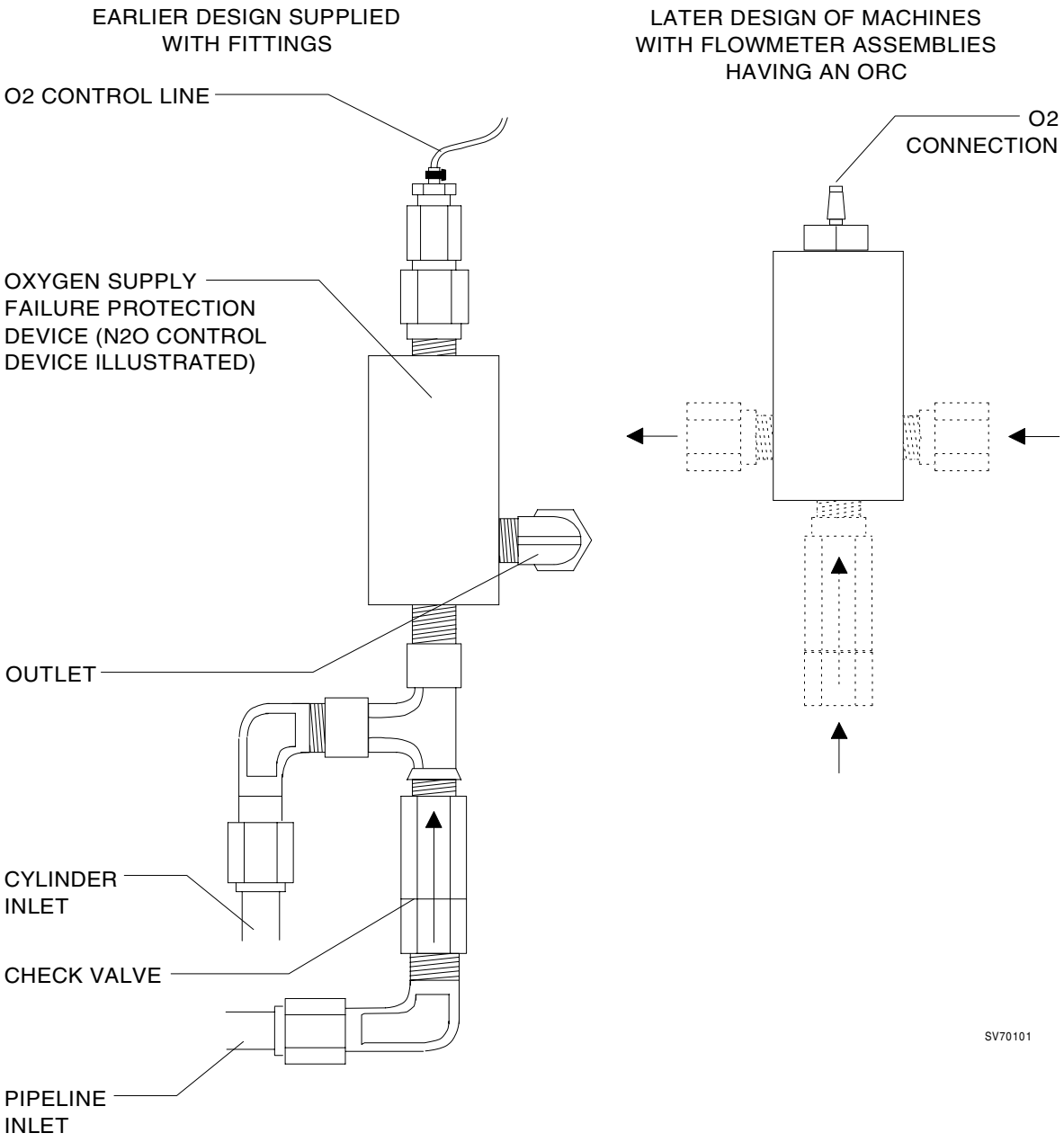



**Figure 4-7: OXYGEN SUPPLY FAILURE PROTECTION DEVICE**

4.7.12 Perform the following test:

4.7.12.1 Open the cylinder valves.

4.7.12.2 Set the System Power switch to ON.

4.7.12.3 Set the oxygen flow to five liters per minute.

4.7.12.4 Set the other gas flow to five liters per minute.

4.7.12.5 Close the oxygen cylinder valve.

4.7.12.6 As the oxygen flow decreases, the other gas flow should also decrease proportionally.

4.7.12.7 Set the System Power switch to STANDBY.

4.7.13 Replace the rear cover and its retaining screws.

4.7.14 Connect the pipeline hoses.

4.7.15 Perform the PMS Procedure given in Section 6.

## 4.8 Oxygen Supply Pressure Alarm Switch (earlier machines)

The oxygen supply pressure alarm switch is located behind the gas instrumentation panel. Access to the switch requires removal of the flowmeter housing rear cover. The replacement switch must be tested to ensure that its operating point is set correctly. Figure 4-8 shows the switch assembly on earlier machines where the switch is supported by the $O_2$ tubing.

On later machines with flowmeter assemblies having an Oxygen Ratio Controller (ORC), the oxygen supply pressure alarm switch is part of the alarm channel assembly. Refer to the procedure titled "Alarm Channel and Oxygen Supply Pressure Alarm Switch" for specific replacement instructions.

4.8.1 Disconnect all pipeline hoses and set the System Power switch to ON.

4.8.2 Close all cylinder valves except the $O_2$ valve.

4.8.3 Set the oxygen flow to 5 liters per min.

4.8.4 Open the other gas flow control valves to drain pressure from the system.

4.8.5 Close the $O_2$ cylinder valve and the $O_2$ flow control valve. Press the $O_2$ Flush valve to drain oxygen pressure from the system.

4.8.6 Set the System Power switch to STANDBY.

4.8.7 Remove the screws holding the rear cover, and remove the cover.

4.8.8 Disconnect the two compression fittings at the TEE.

4.8.9 Note the position of the wires on the switch so that the replacement unit can be connected in the same manner. Disconnect the wires from the switch and remove the assembly.

4.8.10 Connect the wires to the replacement assembly; connect and tighten the compression fittings on the $O_2$ lines.

4.8.11 Remove the screws holding the table top to the machine and lift out the table top.

4.8.12 Pull the writing or keyboard tray out to its fully extended position.

4.8.13 Locate the TEE fitting in the ¼ in. diameter output line of the $O_2$ regulator and remove the plug from the TEE fitting.

4.8.14 Connect a dedicated $O_2$ test gauge to the TEE fitting.

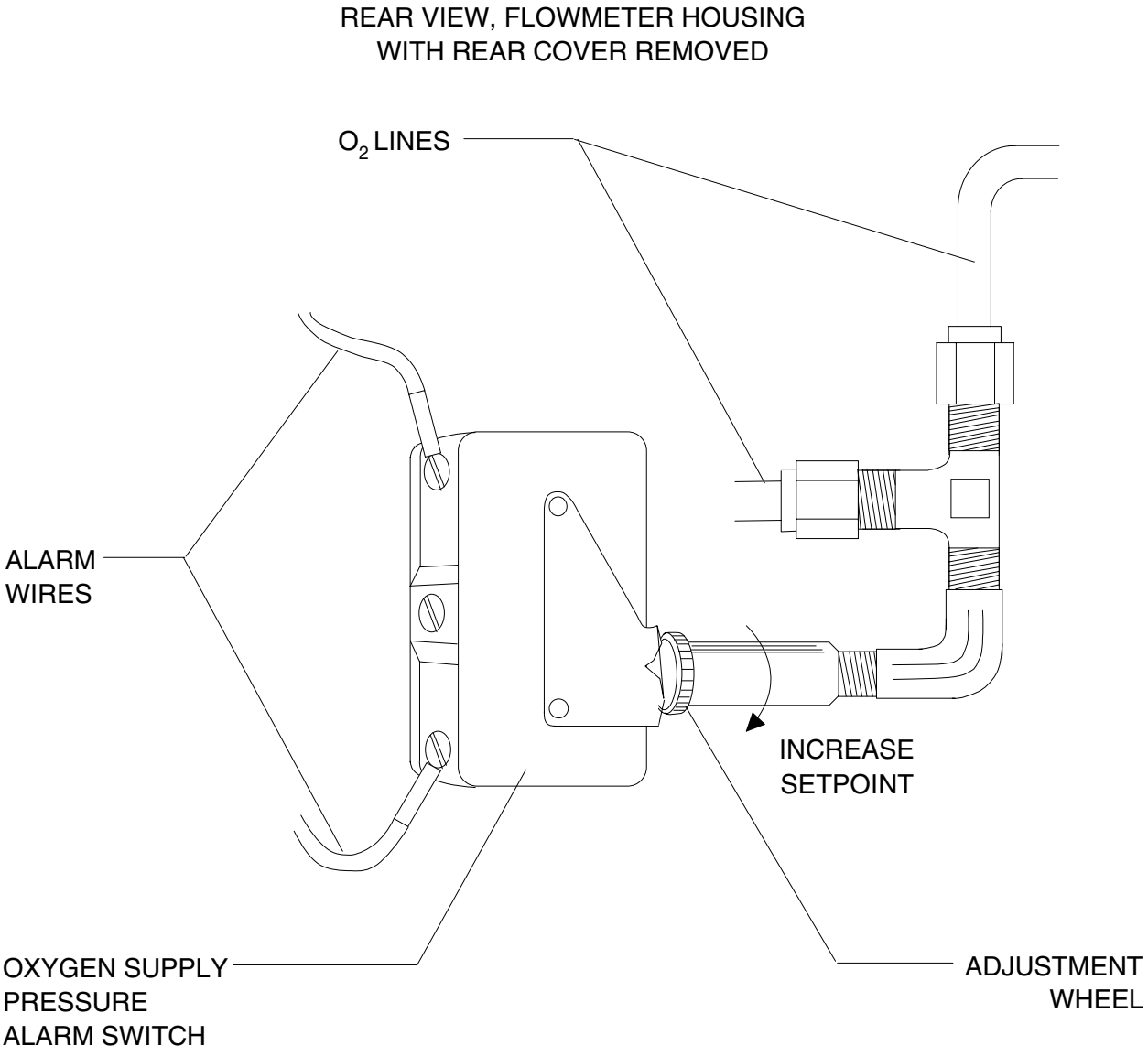



**Figure 4-8: OXYGEN SUPPLY PRESSURE ALARM SWITCH**

4.8.15 Open the oxygen cylinder valve and set the System Power switch to ON.

4.8.16 Set the oxygen flow to five liters per minute.

4.8.17 Close the oxygen cylinder valve.

4.8.18 As the pressure drops, the $O_2$ SUPPLY alarm should activate when the pressure is between 40 and 34 psi as shown on the test gauge.

4.8.19 If the alarm activates when the pressure is below 34 psi, turn the adjustment wheel counter-clockwise, repeat the test and adjust as necessary to bring the set point into the correct range.

If the alarm activates when the pressure is above 40 psi, turn the adjustment wheel clockwise,repeat the test and adjust as necessary to bring the set point into the correct range.

4.8.20 Set the System Power switch to STANDBY.

4.8.21 Disconnect the test gauge and replace the plug in the regulator line TEE fitting.

4.8.22 Replace the table top and its retaining screws.

4.8.23 Replace the rear cover and its retaining screws.

4.8.24 Connect the pipeline hoses.

4.8.25 Perform the PMS Procedure given in Section 6.

## 4.9 Oxygen Supply Pressure Alarm Whistle (Canada)

The oxygen supply pressure alarm whistle is located inside the flowmeter housing. Access to the whistle assembly requires removal of the flowmeter housing rear cover. Figure 4-9 shows the arrangement of the whistle assembly within the flowmeter housing, and indicates the compression fittings that need to be disconnected in order to remove the assembly.

4.9.1 Set the System Power switch to STANDBY, and remove AC power from the machine.

4.9.2 Close all cylinder valves and disconnect the pipeline hoses.

4.9.3 Press the $O_2$ FLUSH button to remove pressure from the oxygen circuit.

4.9.4 Remove the screws holding the flowmeter housing rear cover, and remove the cover.

4.9.5 Disconnect the three compression fittings at the locations shown in the illustration, and remove the whistle assembly.

4.9.6 Position the replacement whistle assembly in the flowmeter housing, connect and tighten the three compression fittings.

4.9.7 Replace the flowmeter housing rear cover and its retaining screws.

4.9.8 Connect the pipeline hoses and perform the following test:

-- Set the System Power switch to ON.

-- Set the oxygen flow rate to 1 l/min.

-- Close the pipeline supply valve and observe the pipeline pressure gauge.

-- The alarm whistle shall sound for a minimum of 10 seconds when the pressure drops below the range of 35 to 30 PSI.

4.9.9 Perform the PMS Procedure given in Section 6.

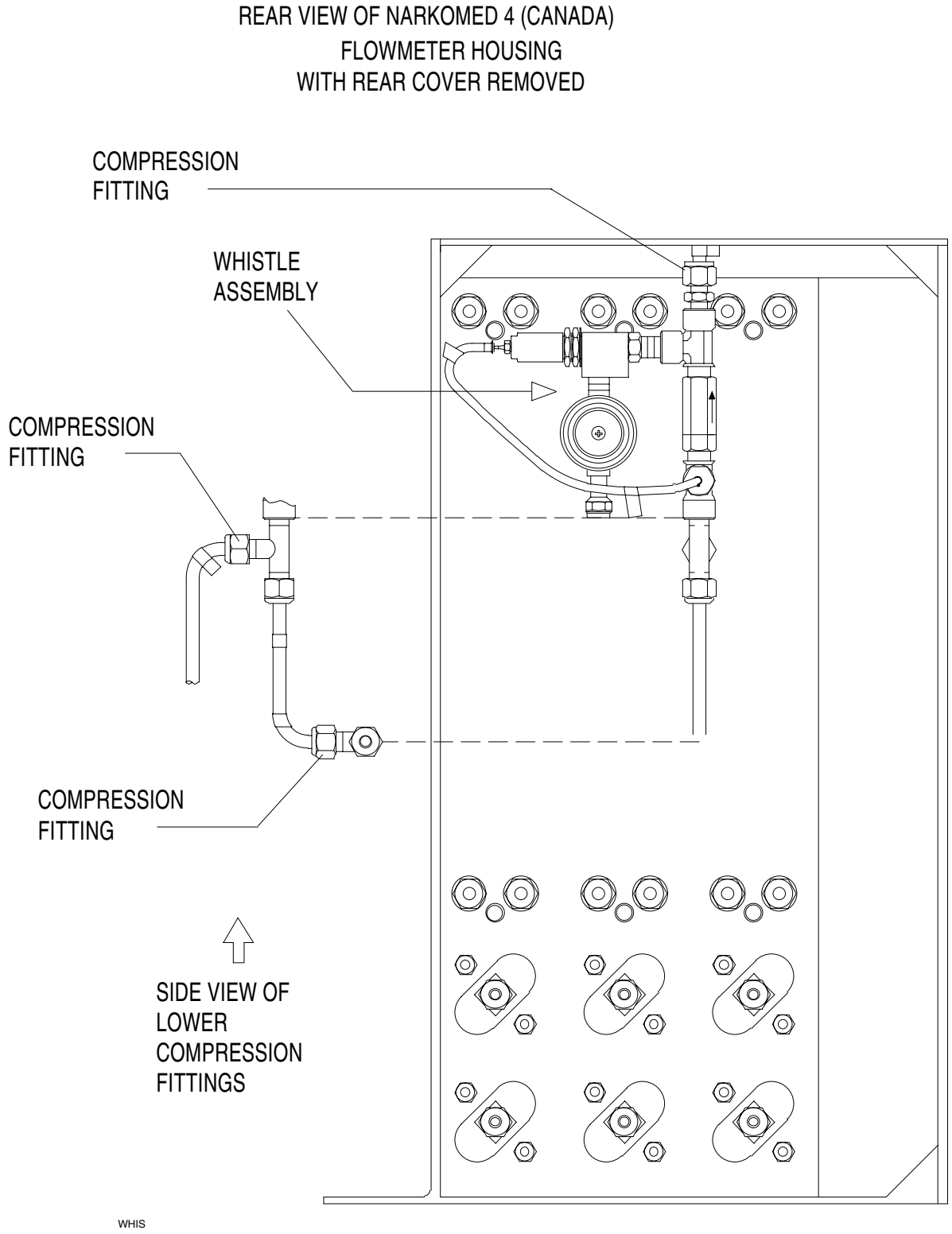



**Figure 4-9: OXYGEN SUPPLY PRESSURE ALARM WHISTLE (CANADA)**

## 4.10 Oxygen Ratio Monitor/Controller

The oxygen ratio monitor/controller (ORMC) is located in the vapor box and is accessible by removing the rear cover panel above the vaporizer mounts. Figure 4-10 shows the location of the ORMC mounting screws and connections. Test and adjustment instructions are included in the following procedure.

NOTE: Steps marked with an asterisk (*) do not apply to later model machines that do not have the $O_2/N_2O$ ratio lamp on the alarm channel.

4.10.1 Disconnect all pipeline hoses and set the System Power switch to ON.

4.10.2 Close all cylinder valves except the $O_2$ valve.

4.10.3 Set the oxygen flow to 5 liters per min.

4.10.4 Open the other gas flow control valves to drain pressure from the system.

4.10.5 Close the $O_2$ cylinder valve and the $O_2$ flow control valve. Press the $O_2$ Flush valve to drain oxygen pressure from the system.

4.10.6 Set the System Power switch to STANDBY.

4.10.7 Remove the four screws holding the vapor box rear cover, and remove the cover.

4.10.8 Remove the two screws holding the ORMC to the bottom of the vapor box.

4.10.9 Remove the four screws holding the bottom plate of the vapor box, and remove the plate to gain access to the ORMC connections.

4.10.10 Disconnect the flexible $O_2$ tubing from the left side of the ORMC, and disconnect the flexible $N_2O$ tubing from the right side of the MPL switch. (Later models do not have the MPL switch.)

* 4.10.11 Cut the tie-wrap clamp on the in-line wiring harness connectors, and separate the two ORMC connections.

4.10.12 While holding the ORMC, carefully disconnect the compression fittings on the $N_2O$ lines.

4.10.13 Disconnect the remaining flexible $N_2O$ tubing from the tee fitting at the front of the ORMC. (Later models do not have the tee fitting.)

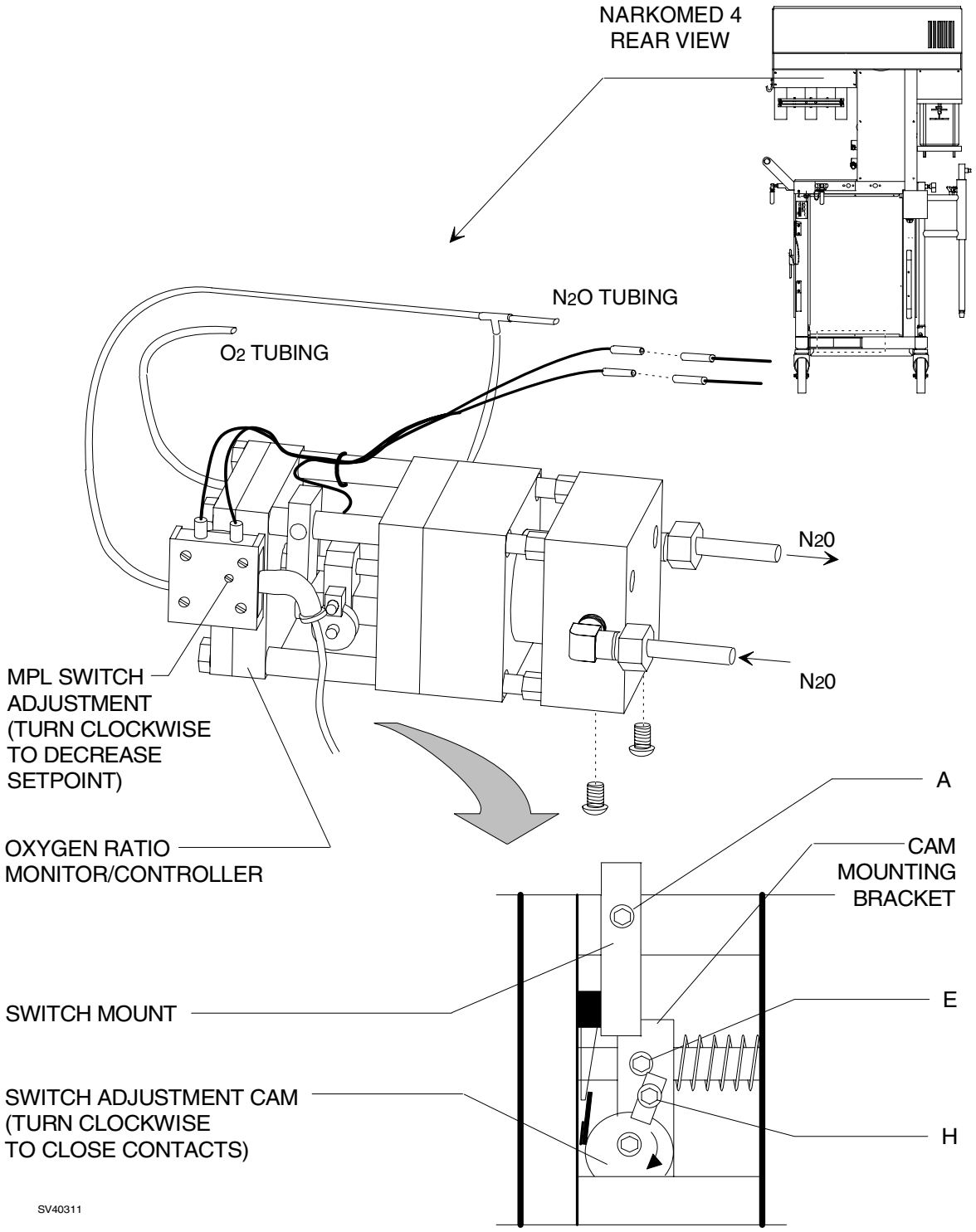



**Figure 4-10: OXYGEN RATIO MONITOR/CONTROLLER**

4.10.14 Connect the flexible $N_2O$ tubing that was removed in the previous step to the tee fitting at the front of the replacement ORMC, and secure the connection with a new tie strap clamp. (Later models do not have the tee fitting.)

4.10.15 Connect the copper $N_2O$ lines to the replacement ORMC and tighten the compression fittings.

* 4.10.16 Join the in-line wiring harness to the replacement ORMC connectors and install a new tie-wrap cable clamp.

4.10.17 Connect the flexible $O_2$ tubing to the left side of the ORMC, and connect the flexible $N_2O$ tubing to right side of the MPL switch. Secure each connection with a press-on clamp. (Later models do not have the MPL switch.)

4.10.18 Open the $O_2$ and $N_2O$ cylinder valves.

4.10.19 Set the System Power switch to ON, and perform the following test:

4.10.19.1 Open the $N_2O$ flow control valve three turns. There should be no nitrous oxide flow.

4.10.19.2 Slowly open the $O_2$ flow control valve. The nitrous oxide should start to flow when the oxygen flow is between 200 and 300 ml per minute.

4.10.19.3 Connect a calibrated oxygen monitor to the Freshgas Outlet.

4.10.19.4 Adjust the oxygen flow to 1 liter per minute. The oxygen concentration should be between 21% and 29% oxygen.

* 4.10.19.5 The yellow $O_2/N_2O$ FLOW RATIO lamp on the alarm panel should be lighted.

4.10.19.6 Adjust the oxygen flow to 1.5 liters per minute. The oxygen concentration should be between 21% and 29% oxygen.

* 4.10.19.7 The yellow $O_2/N_2O$ FLOW RATIO lamp on the alarm panel should be lighted.

4.10.19.8 Adjust the oxygen flow to a point where the nitrous oxide flowmeter indicates 10 liters per minute.

* 4.10.19.9 The yellow $O_2/N_2O$ FLOW RATIO lamp on the alarm panel should be lighted.

4.10.19.10 Close the oxygen flow control valve. The nitrous oxide flow should decrease proportionally, and the oxygen concentration should remain between 21% and 29% oxygen.

4.10.19.11 The nitrous oxide flow should stop when the flow of oxygen is between 200 and 300 ml per minute.

4.10.19.12 Close the $N_2O$ flow control valve and set the System Power switch to STANDBY.

NOTE: If the ORMC is not working properly, perform the adjustment procedure given in Section 5.

4.10.20 Replace the bottom plate of the vapor box. Be sure it is oriented correctly with the ORMC mounting holes in the correct position.

4.10.21 Secure the ORMC to the bottom of the vapor box with its two mounting screws.

4.10.22 Replace the rear cover of the vapor box.

4.10.23 Perform the PMS Procedure given in Section 6.

## 4.11 Oxygen Ratio Controller (later machines)

The Oxygen Ratio Controller (ORC) is part of the $N_2O$ flowmeter sub-assembly and is located within the flowmeter housing. The ORC is accessible by removing the rear flowmeter housing cover. Figure 4-11 shows a typical ORC location and mounting arrangement, with a detail of the O-rings and filter.

The following procedure applies to both ORC designs: P/N 4111800, and Low Flow design P/N 4113229.

4.11.1 Disconnect all pipeline hoses and set the System Power switch to ON.

4.11.2 Close all cylinder valves except the $O_2$ valve.

4.11.3 Set the oxygen flow to 5 liters per min.

4.11.4 Open the other gas flow control valves to drain pressure from the system.

4.11.5 Close the $O_2$ cylinder valve and the $O_2$ flow control valve. Press the $O_2$ Flush valve to drain oxygen pressure from the system.

4.11.6 Set the System, Power switch to STANDBY.

4.11.7 Remove the press-on clamp securing the flexible $O_2$ line to the ORC, and carefully disconnect the tubing from the hose barb.

4.11.8 Remove the three screws holding the ORC to the flowmeter sub-assembly, and carefully remove the ORC from the flowmeter housing.

4.11.9 For low flow ORC (P/N 4113229) replacement, install the 6 in. length of flexible tubing with a blue $N_2O$ label on the replacement ORC (see detail view in illustration) Secure each connection with a press-on hose clamp.

Position the replacement ORC at the back of the $N_2O$ flowmeter sub-assembly; be sure that its O-rings and filter are in place, and install its three mounting screws.

4.11.10 Connect the flexible $O_2$ line to the ORC and secure it with the press-on hose clamp.

4.11.11 Open the $O_2$ and $N_2O$ cylinder valves.

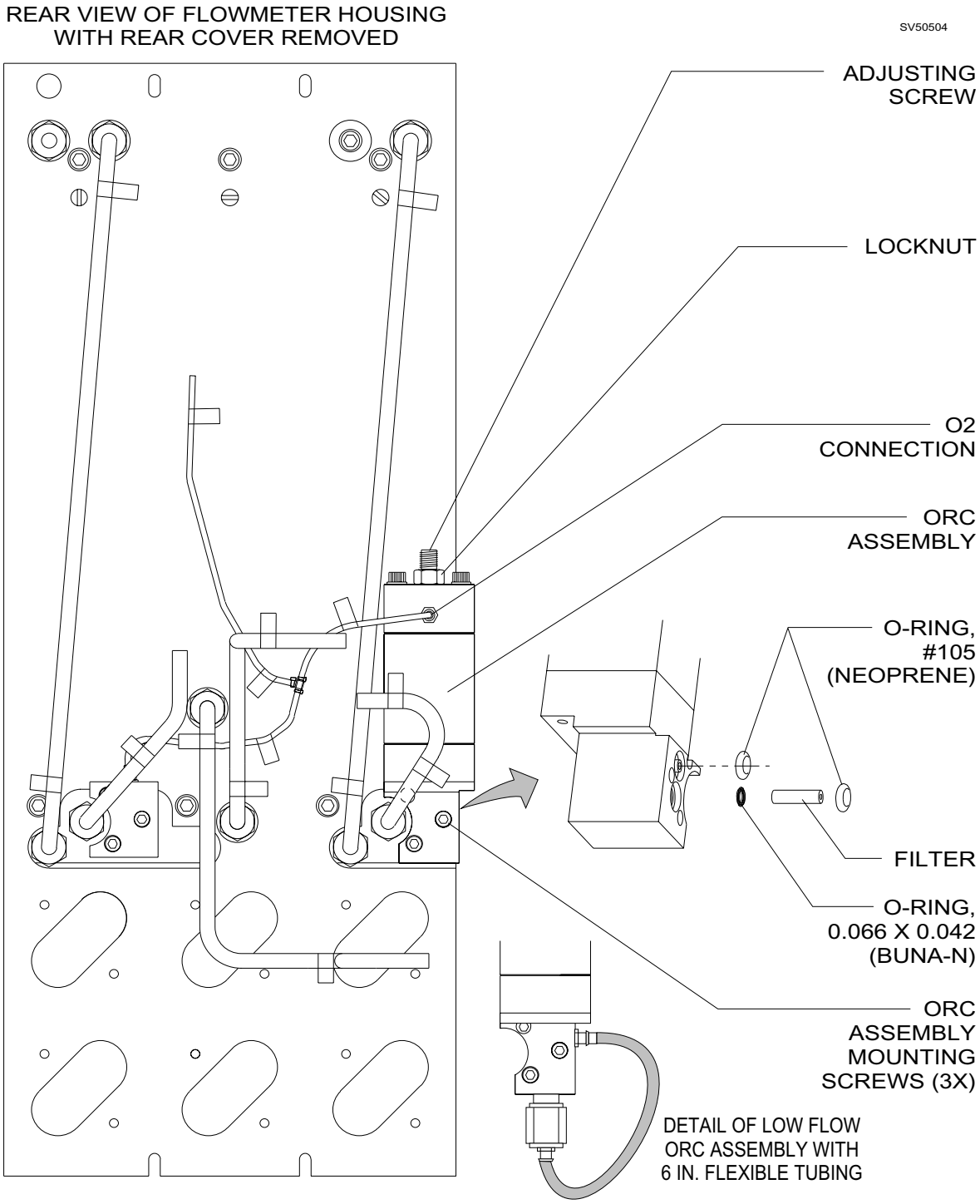



**Figure 4-11: OXYGEN RATIO CONTROLLER**

4.11.12 Perform the ORC adjustment procedure given in Section 5 of this manual.

NOTE: There are two adjustment procedures - one for ORC P/N 4111800, and one for low flow ORC P/N 4113229. Be sure to follow the correct procedure.

4.11.13 Reinstall the flowmeter housing rear cover.

4.11.14 Perform the PMS Procedure given in Section 6.

## 4.12 Vaporizers

Each vaporizer is held to the machine by two metric sized hex screws. These screws are accessible at the back of the vaporizer mount, below the interlock mechanism as shown in Figure 4-12. Before removing a vaporizer from the machine, it must be completely drained and dried in accordance with the procedure given below. Be sure to have a suitable packing or storage container available in which to place the vaporizer.

CAUTION: The following steps must be performed in the sequence given.

4.12.1 Set the System Power switch to ON.

4.12.2 Set all vaporizer handwheels to their Zero or OFF position.

WARNING: Do not inhale anesthetic vapors as this could result in personal injury.

4.12.3 Remove the filler and drain plugs, and drain the vaporizer into a suitable container. Dispose of the residual agent in an approved manner.

4.12.4 Turn the vaporizer handwheel to the maximum concentration setting.

4.12.5 Set the oxygen flow to 10 l/min. for at least 20 minutes.

WARNING: This procedure must be performed in a well ventilated area and without personnel present.

4.12.6 Turn the vaporizer handwheel to 0 (zero), and replace the filler and drain plugs.

4.12.7 Turn the oxygen flow off, and set the System Power switch to STANDBY.

4.12.8 While holding the vaporizer, remove the mounting screws and carefully separate the vaporizer from the machine. Note the arrangement of gaskets so that the replacement vaporizer can be installed in the same manner.

4.12.9 Place the vaporizer in a suitable container for transport or storage.

WARNING: Do not tilt a vaporizer that contains anesthetic agent more than 45 degrees. Failure to observe this precaution will render the handwheel calibration invalid.

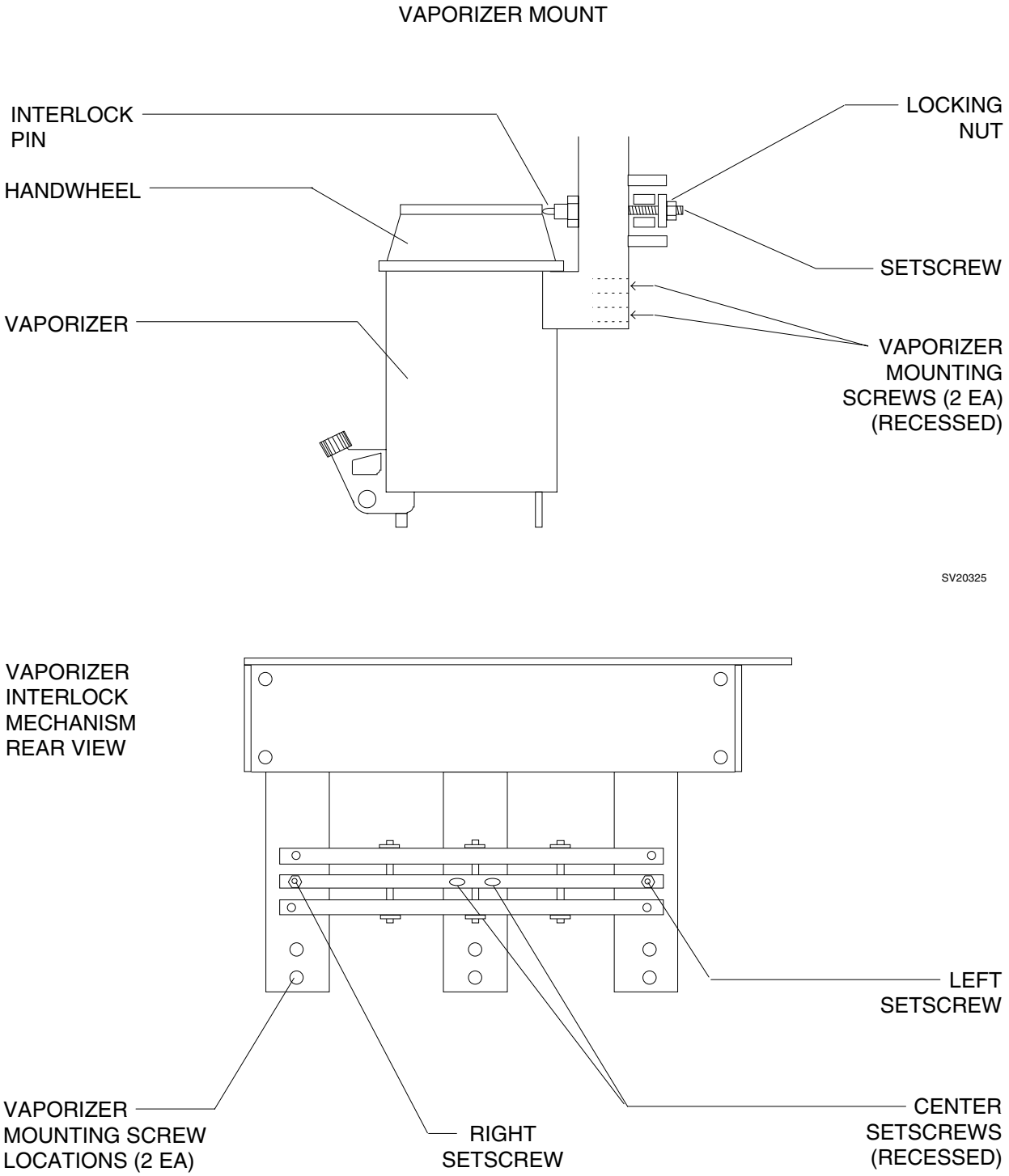



**Figure 4-12: VAPORIZER INSTALLATION AND INTERLOCK ADJUSTMENT**

NOTE: Should a vaporizer containing anesthetic agent be accidentally tilted more than 45 degrees, it must be drained and flushed in accordance with instructions given in the manual supplied with the vaporizer.

4.12.10 Set the handwheel on the replacement vaporizer to its Zero position.

4.12.11 Install the replacement vaporizer on the machine (be sure the O-rings are in place) and tighten the mounting screws to a torque of 24 to 26.5 inch pounds.

4.12.12 Perform the following test on the interlock mechanism and make any necessary adjustments:

4.12.12.1 Turn the center vaporizer handwheel ON. The left and the right vaporizer handwheels should be locked in their Zero position. If the left or right vaporizer does not lock, tighten the corresponding center set screw until the handwheel locks properly.

4.12.12.2 Turn the center vaporizer OFF and turn the left vaporizer ON. The center and the right vaporizer handwheels should be locked in their Zero position. If the right vaporizer does not lock, loosen the locking nut on the right set screw and adjust the set screw until the handwheel locks properly. Tighten the locking nut while holding the set screw to maintain the correct adjustment.

NOTE: Do not over-tighten the set screws. Each vaporizer handwheel must turn easily while the other vaporizers are locked .

4.12.12.3 Turn the left vaporizer OFF and turn the right vaporizer ON. The center and the left vaporizer handwheels should be locked in their Zero position. If the left vaporizer does not lock, loosen the locking nut on the left set screw and adjust the set screw until the handwheel locks properly. Tighten the locking nut while holding the set screw to maintain the correct adjustment.

4.12.13 Perform the PMS Procedure given in Section 6.

## 4.13 O2 Flush Valve

The $O_2$ flush valve is located at the front of the machine next to the freshgas outlet. Access to the flush valve requires removal of the table top. Figure 4-13 shows the mounting and assembly details of the flush valve.

4.13.1 Set the System Power switch to STANDBY.

4.13.2 Disconnect all pipeline hoses.

4.13.3 Close the $O_2$ cylinder valve.

4.13.4 Press the $O_2$ Flush valve to drain oxygen pressure from the system.

4.13.5 Remove the screws holding the table top to the machine and lift out the table top.

4.13.6 Hold the $O_2$ Flush button in and rotate it until one of its set screws are visible through an access hole in the guard ring, and loosen the set screw.

4.13.7 Turn the $O_2$ Flush button 180 degrees, hold it in and loosen the other set screw.

4.13.8 Remove the $O_2$ Flush button and washer from the valve shaft.

4.13.9 Disconnect the two compression fittings at the valve.

NOTE: Do not lose the flow restrictor located at the right-angle fitting. This restrictor will be transferred to the replacement valve assembly.

4.13.10 The $O_2$ Flush valve is retained by the guard ring on the front of the machine frame. Hold the body of the Clippard valve with an open end wrench; insert a rod or hex wrench through the holes in the guard ring (or use a spanner wrench), and un-screw the guard ring from the front of the frame rail.

4.13.11 Assemble the replacement $O_2$ Flush valve, spacer, internal tooth lock washer and guard ring through the frame and tighten the assembly, making sure that the valve is mounted straight.

4.13.12 Connect the compression fittings to the valve. Be sure the flow restrictor is in place at the right-angle fitting.

4.13.13 Place the washer and the $O_2$ Flush button on the valve shaft.

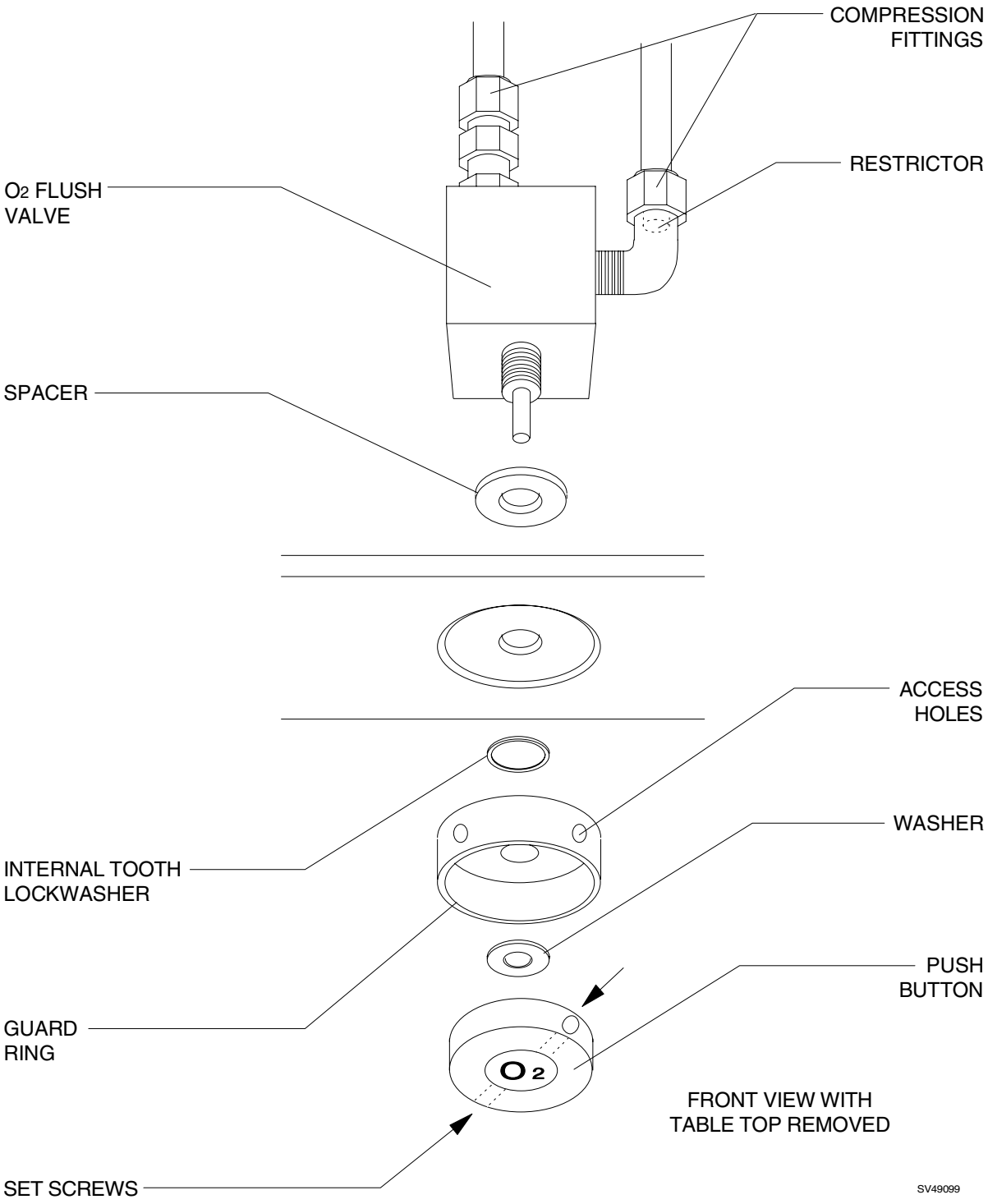



**Figure 4-13: $O_2$ FLUSH VALVE**

4.13.14 Hold the $O_2$ Flush button in and turn it until a set screw is visible through an access hole in the guard ring. Tighten the set screw. Rotate the button 180 degrees until the other set screw is visible, and tighten the set screw.

4.13.15 Disconnect the absorber freshgas hose from the freshgas outlet. Connect a test gauge and B.P. bulb to the freshgas outlet, and perform the following test:

4.13.15.1 Open the oxygen cylinder valve.

4.13.15.2 Release any pressure that is indicated on the test gauge.

4.13.15.3 Over the next 60 seconds, the test gauge should not show a pressure increase greater than 2 cm $H_2O$.

4.13.15.4 Increase the pressure to 50 cm $H_2O$.

4.13.15.5 The pressure should not drop more than 10 cm $H_2O$ in the next 30 seconds.

4.13.15.6 Disconnect the test gauge from the freshgas outlet.

4.13.15.7 Open the oxygen cylinder valve and allow the pressure to stabilize. (The cylinder pressure must be at least 1000 psi for this test.)

4.13.15.8 Close the oxygen cylinder valve.

4.13.15.9 The pressure should not drop more than 50 psi in two minutes.

4.13.15.10 Connect a volumeter to the freshgas outlet, and reset the volumeter to zero.

4.13.15.11 Press the $O_2$ Flush button and observe the flow rate. It should be between 45 and 65 liters per minute.

4.13.15.12 Disconnect the volumeter from the freshgas outlet.

4.13.16 Connect the absorber freshgas hose to the freshgas outlet.

4.13.17 Replace the table top and secure it with the mounting screws.

4.13.18 Connect the pipeline hoses.

4.13.19 Perform the PMS Procedure given in Section 6.

## 4.14 AV-E Ventilator Controller Assembly

The ventilator controller assembly is located in the left side of the ventilator box. Access to the controller requires removing the front panel from the ventilator box. Figure 4-14 shows the mounting screw locations and cable connections to the ventilator controller.

4.14.1 Set the System Power switch to STANDBY.

4.14.2 Remove the four screws holding the ventilator box front panel. Remove the panel and carefully separate the ventilator switch in-line connector.

4.14.3 Remove the two screws holding the ventilator controller assembly to the floor of the ventilator box.

4.14.4 Pull the controller assembly forward and disconnect the two cables from J1 and J2 at the back of the assembly, and remove the controller assembly.

4.14.5 Plug the cables that were previously removed into J1 and J2 on the back of the replacement controller assembly.

4.14.6 Mount the replacement controller assembly to the floor of the ventilator box and secure it with the two mounting screws.

4.14.7 Join the ventilator switch in-line connector, and replace the front panel of the ventilator box.

4.14.8 Perform the PMS Procedure given in Section 6.

NARKOMED 4 VENTILATOR BOX TOP VIEW

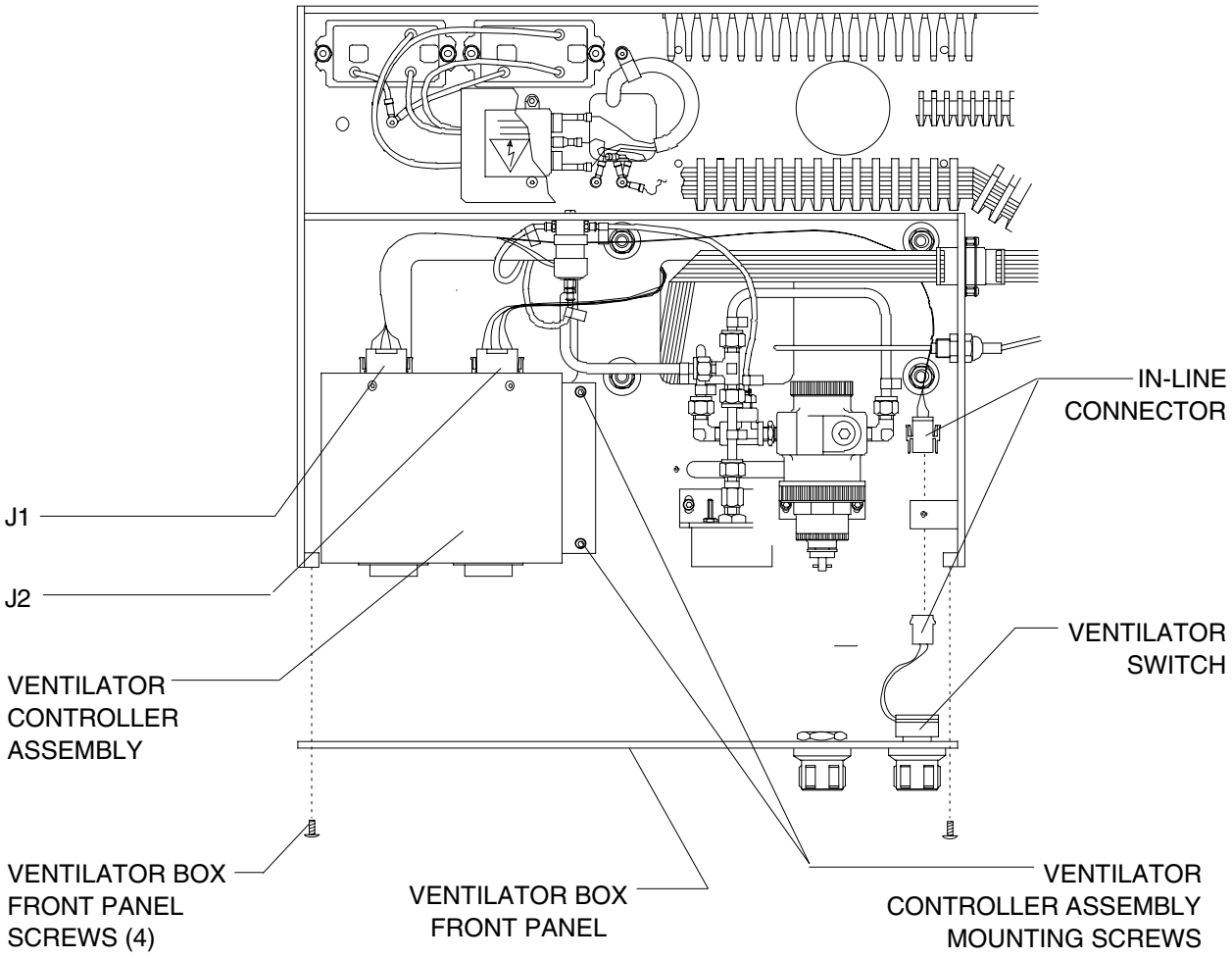



**Figure 4-14: AV-E VENTILATOR CONTROLLER ASSEMBLY**

## 4.15 AV-E Ventilator Solenoid Valve

The ventilator solenoid valve is located in the ventilator box and is mounted on the inner back wall of the box. Replacement of the solenoid valve requires lifting the monitor box to gain access to its mounting and connections. Figure 4-15 shows the mounting location, electrical connections and tubing arrangement of the solenoid valve.

4.15.1 Set the System Power switch to STANDBY and remove AC power from the machine.

4.15.2 Disconnect the following items from the patient interface panel on the left side of the monitor box:

-Remote Display and Datagrip cables

-BP Cuff and BP Gauge lines

-Pulse Oximeter Sensor cable

4.15.3 Remove the disposable reservoir from its holder.

4.15.4 Remove the six screws holding the monitor box cover, and carefully lift the cover from the monitor box.

4.15.5 Remove the four screws holding the monitor box to the ventilator box.

4.15.6 Disconnect the ribbon cable from J32 on the backplane.

4.15.7 Raise the rear of the monitor box chassis approximately two inches, and prop the box open.

WARNING: Ensure that AC power is removed from the machine before raising the monitor box. Failure to observe this precaution may cause injury by electric shock.

4.15.8 Remove the two screws holding the safety cover over the AC power filter, and remove the cover.

4.15.9 Remove the two screws holding the solenoid valve to the inner wall of the ventilator box.

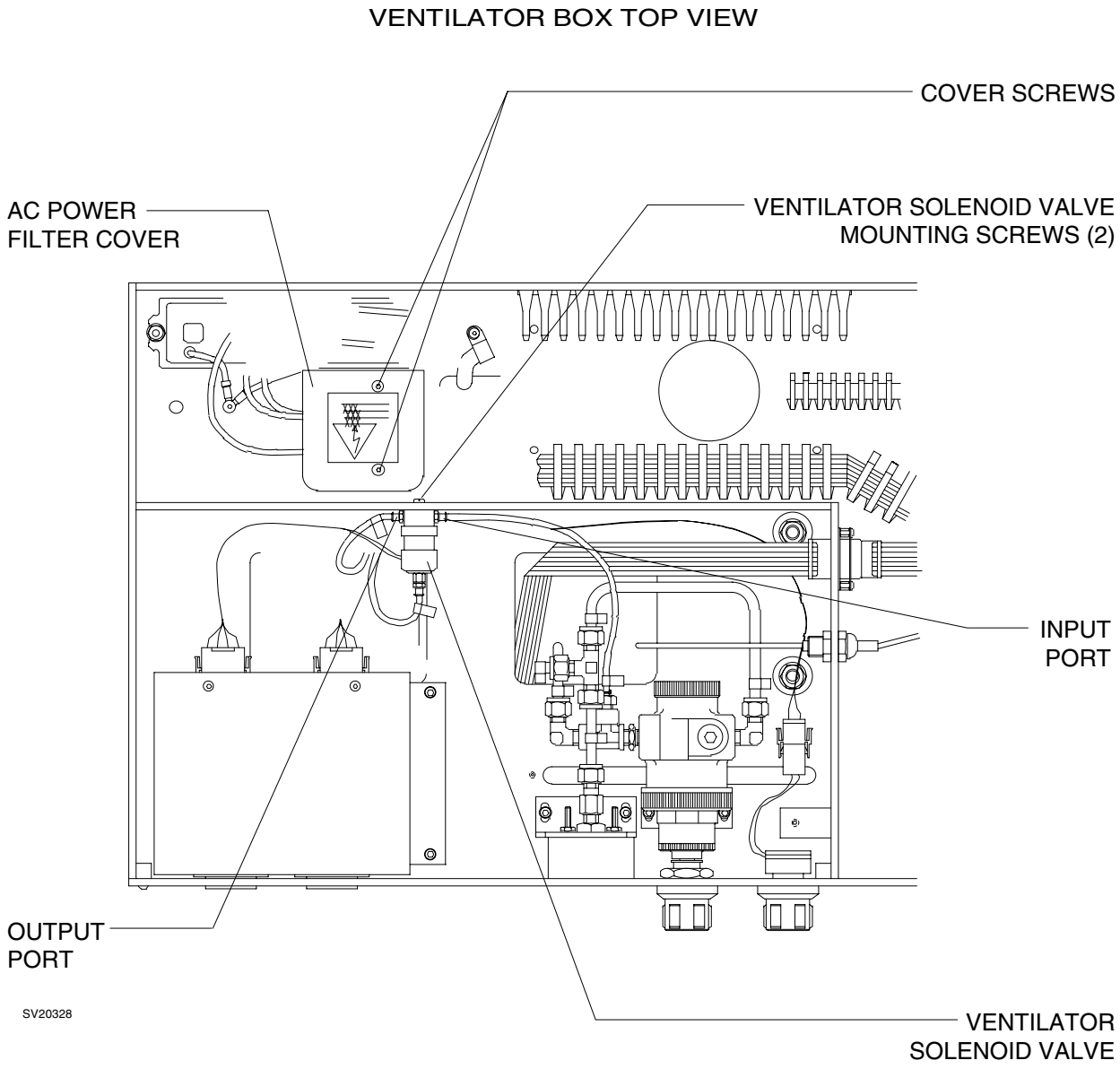



**Figure 4-15: AV-E VENTILATOR SOLENOID VALVE**

4.15.10 Remove the prop from the rear of the monitor box, and return the box to its normal position.

4.15.11 Raise the front of the monitor box approximately four inches, and prop the box open.

4.15.12 Pull the solenoid valve forward to gain access to its connections, and remove the electrical connections.

4.15.13 Remove the three flexible tubing connections and remove the solenoid valve. Mark each tube so that the replacement solenoid can be connected in the same manner.

4.15.14 Connect the flexible tubing to the replacement solenoid valve.

4.15.15 Connect the two wires to the solenoid, and place the solenoid near its mounting position.

4.15.16 Remove the prop from the front of the monitor box and lower the box to its original position.

4.15.17 Raise the rear of the monitor box chassis approximately two inches, and prop the box open.

4.15.18 Mount the solenoid valve to the ventilator box using the original hardware.

4.15.19 Replace the safety cover over the AC power filter and secure it with the two screws.

4.15.20 Remove the prop from the rear of the monitor box, and return the box to its normal position.

4.15.21 Replace the four screws holding the monitor box to the ventilator box.

4.15.22 Connect the ribbon cable that was previously removed from J32 on the backplane.

4.15.23 Place the cover over the monitor box and secure it with its six screws.

4.15.24 Connect the remote display cable, BP cuff and BP gauge lines, and pulse oximeter sensor cable to the patient interface panel. Install the disposable reservoir in its holder.

4.15.25 Restore power to the machine and perform the PMS Procedure given in Section 6.

## 4.16 AV-2 and AV2+ Ventilator Controller Assembly

The Ventilator Controller assembly is attached to the left front panel of the ventilator box and includes electrical and pneumatic components. Figures 4-16 and 4-16A show the mounting screw locations and connections to the ventilator controller. Flexible tubing allows the assembly to be pulled from the front of the ventilator box without raising the monitor box.

4.16.1 Set the System Power switch to STANDBY and remove AC power from the machine.

4.16.2 Disconnect all pipeline hoses and close all cylinder valves.

CAUTION: The controller circuit board contains static sensitive devices. Use ESD protection when handling the controller assembly.

4.16.3 Remove the two screws securing the left end of the ventilator controller panel.

4.16.4 Pull the left side of the panel outward, slide it to the left until the locking tab on the right side of the panel is clear of its receptacle, then pull the assembly out far enough to gain access to its connections.

4.16.5 Disconnect the alarm channel wiring harness from J2 on the controller circuit board. On AV2+ controllers, also disconnect the Man/Auto selector interface cable from J7 on the circuit board.

4.16.6 Disconnect the following large and small diameter pneumatic tubing (the letters are keyed to the illustration):

**A:** Small dia. tube from solenoid to rear vent fitting on bellows box
**B:** Large dia. tube from supply valve to venturi
**C:** Small dia. tube to auto-ranging valve
**D:** Large dia. tube from main switch ($O_2$ supply)

4.16.7 Remove the controller assembly from the machine.

4.16.8 Position the replacement controller assembly in the ventilator box and reconnect the four pneumatic lines.

4.16.9 Reconnect the alarm channel wire harness to J2 on the controller circuit board. On AV2+ controllers, also reconnect the Man/Auto selector interface cable to J7 on the circuit board.

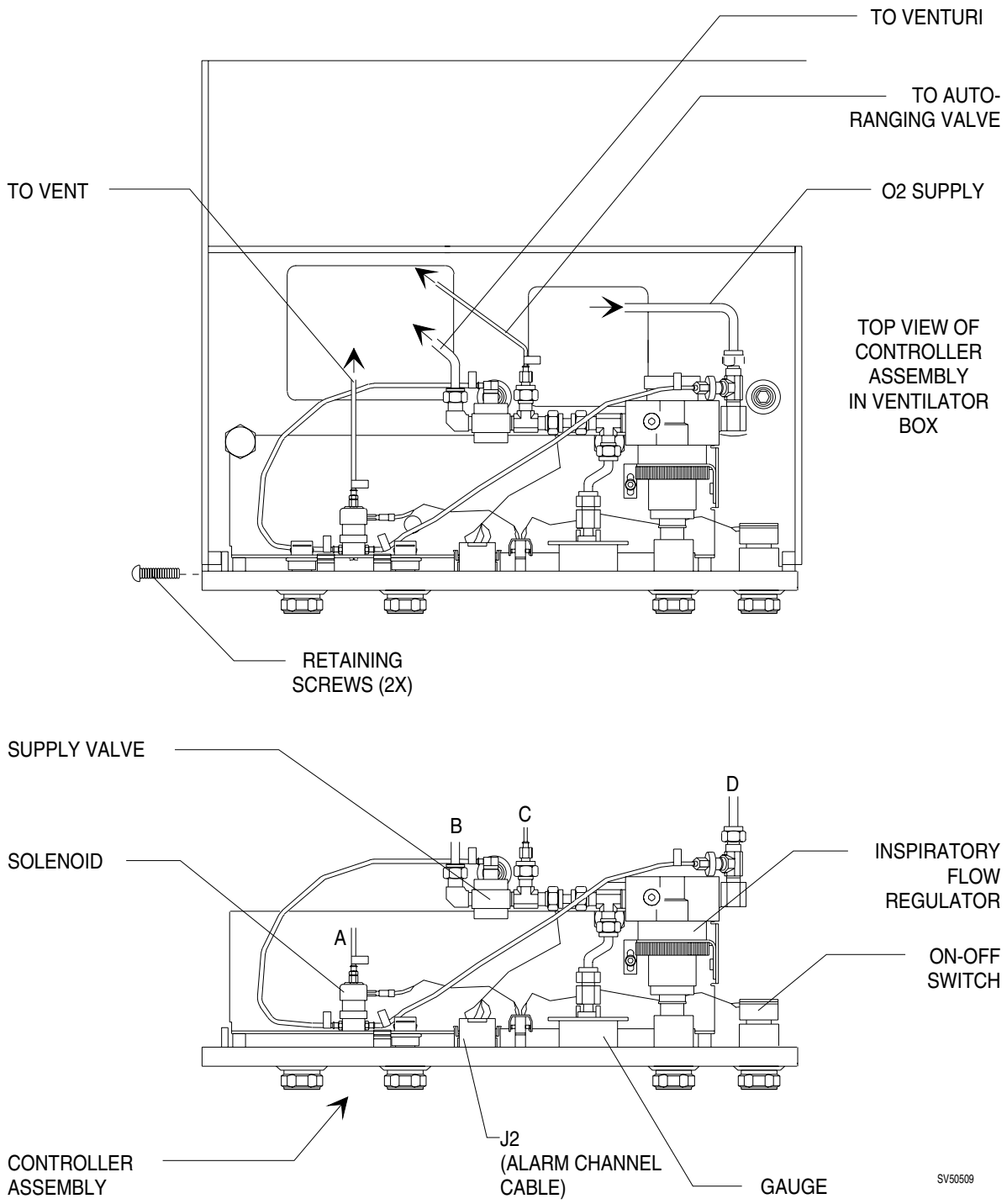



**Figure 4-16: AV-2 VENTILATOR CONTROLLER ASSEMBLY**

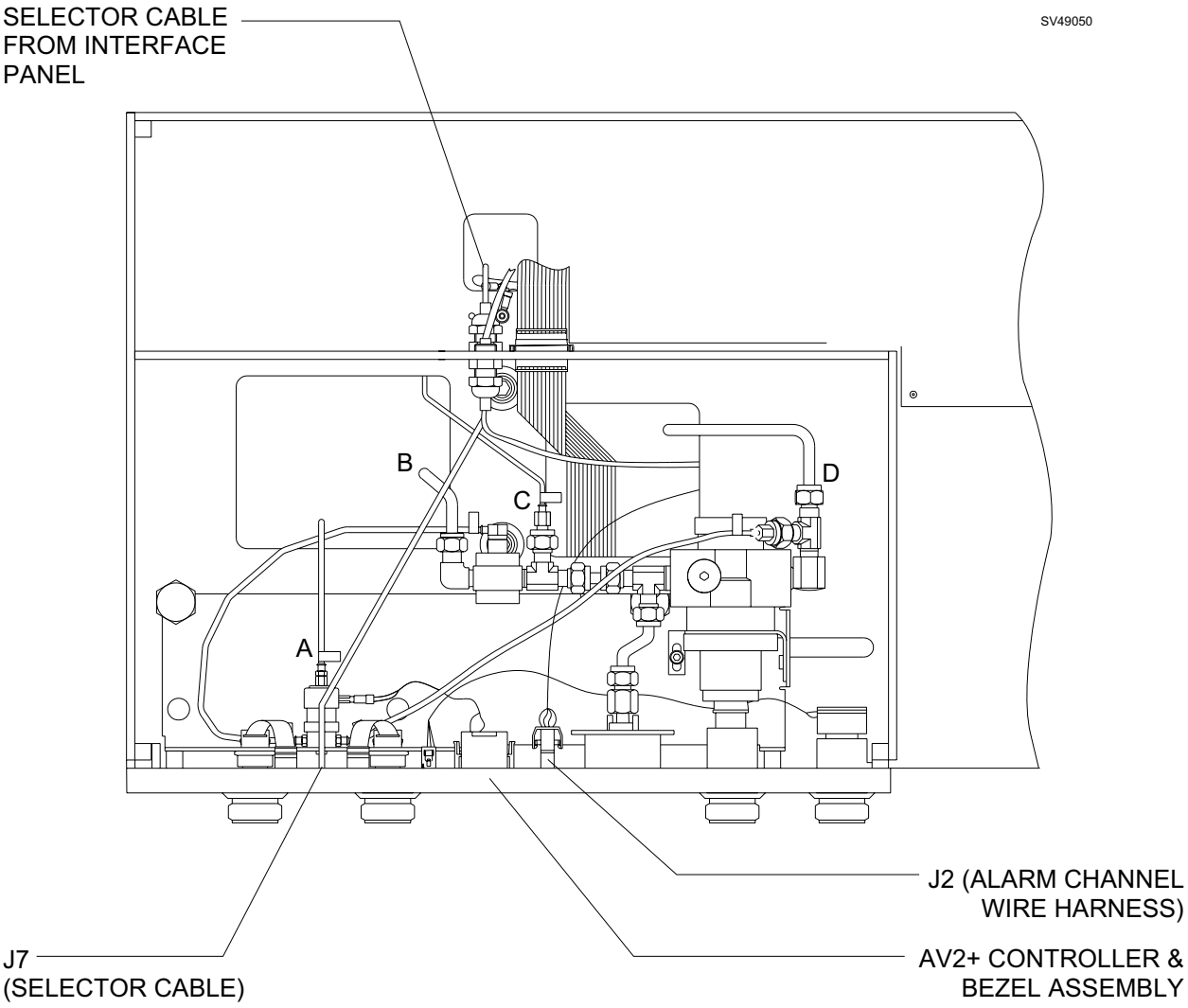



**Figure 4-16A: AV-2+ VENTILATOR CONTROLLER ASSEMBLY**

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4.16.10 Slide the controller into the ventilator box, carefully fit the locking tab into its receptacle at the right side of the panel, and slide the assembly to the right until it is properly seated.

4.16.11 Reinstall the two retaining screws at the left side of the panel.

4.16.12 Perform the PMS Procedure given in Section 6.

## 4.17 Convenience Outlet AC Power Filter

The convenience outlet AC power filter is located in the back of the ventilator box near the AC convenience outlets. Access to the power filter requires lifting the monitor box. Figure 4-17 shows the location of the filter, its connections and its mounting arrangement.

4.17.1 Set the System Power switch to STANDBY and remove AC power from the machine.

4.17.2 Disconnect the following items from the patient interface panel on the left side of the monitor box:

-Remote Display and Datagrip cables

-BP Cuff and BP Gauge lines

-Pulse Oximeter Sensor cable

4.17.3 Remove the disposable reservoir from its holder.

4.17.4 Remove the six screws holding the monitor box cover, and carefully lift the cover from the monitor box.

4.17.5 Remove the four screws holding the monitor box to the ventilator box.

4.17.6 Disconnect the ribbon cable from J32 on the backplane.

4.17.7 Raise the rear of the monitor box chassis approximately two inches, and prop the box open.

WARNING: Ensure that AC power is removed from the machine before raising the monitor box. Failure to observe this precaution may cause injury by electric shock.

4.17.8 Remove the two screws holding the safety cover over the AC power filter, and remove the cover.

4.17.9 Disconnect the AC wiring from each side of the filter. Note the position of the wires so they can be re-installed in the same manner.

NARKOMED 4 VENTILATOR BOX TOP VIEW

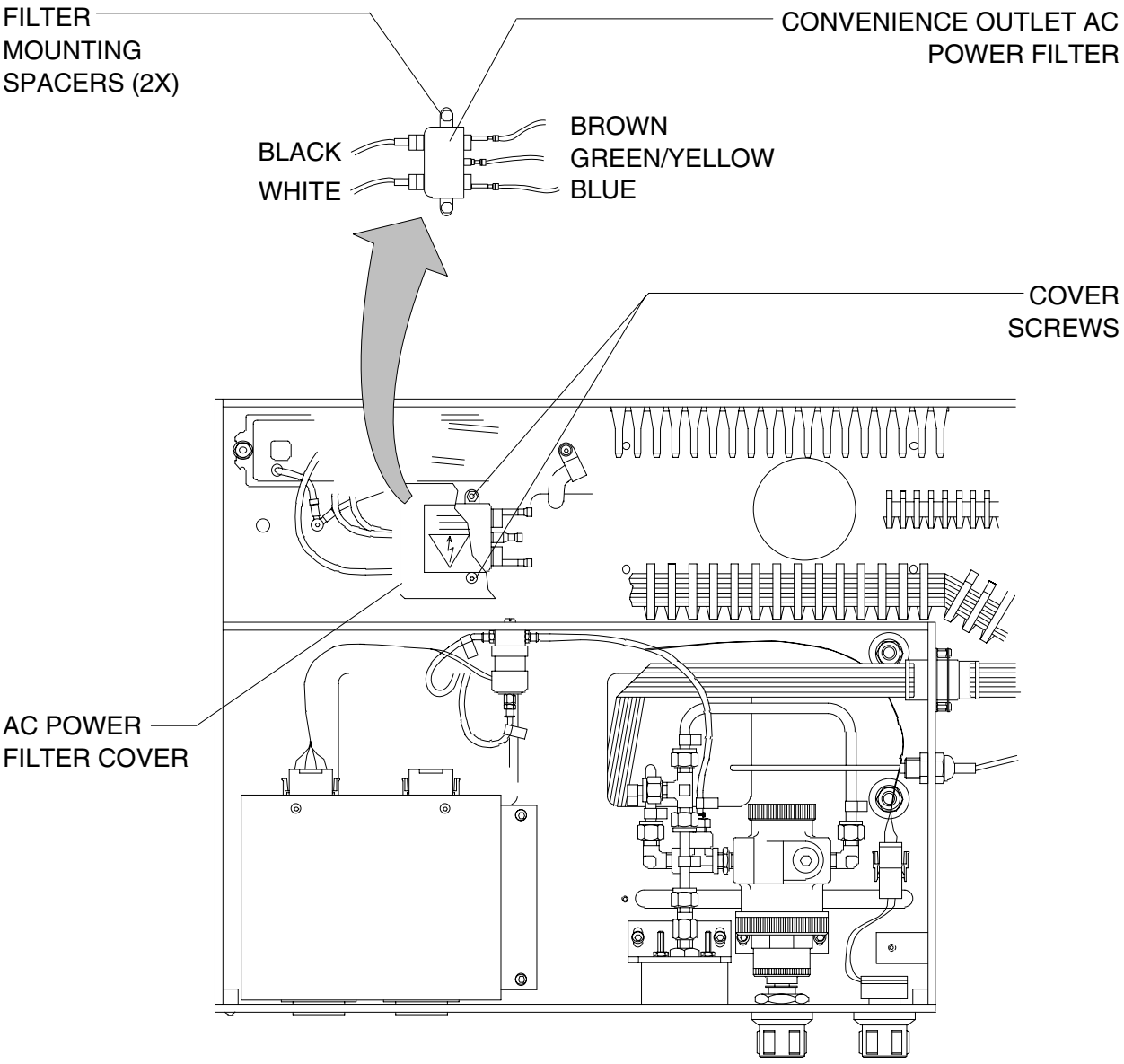



**Figure 4-17: CONVENIENCE OUTLET AC POWER FILTER**

4.17.10 Unscrew the two hex post nuts holding the filter to the ventilator box, and remove the filter.

4.17.11 Install the replacement filter and secure it with the two hex post nuts.

4.17.12 Connect the AC wiring to the replacement filter. Be sure to observe the wire color code as illustrated.

4.17.13 Place the safety cover over the filter and secure it with the two screws.

4.17.14 Remove the prop from the rear of the monitor box, and return the box to its normal position.

4.17.15 Replace the four screws holding the monitor box to the ventilator box.

4.17.16 Connect the ribbon cable that was previously removed from J32 on the backplane.

4.17.17 Place the cover over the monitor box and secure it with its six screws.

4.17.18 Connect the remote display cable, BP cuff and BP gauge lines, and pulse oximeter sensor cable to the patient interface panel. Install the disposable reservoir in its holder.

4.17.19 Restore power to the machine and perform the PMS Procedure given in Section 6.

## 4.18 AV-E Inspiratory Flow Regulator

The inspiratory flow regulator is located in the ventilator box. Access to the regulator requires removal of the ventilator box front panel, and lifting the monitor box. Figure 4-18 shows the regulator mounting arrangement and its connections.

4.18.1 Set the System Power switch to STANDBY.

4.18.2 Remove the four screws holding the ventilator box front panel. Remove the panel and carefully separate the ventilator switch in-line connector.

4.18.3 Remove the four screws holding the monitor box to the ventilator box.

4.18.4 Raise the front of the monitor box chassis approximately four inches, and prop the box open.

WARNING: Ensure that AC power is removed from the machine before raising the monitor box. Failure to observe this precaution may cause injury by electric shock.

4.18.5 Disconnect the two compression fittings at the regulator.

4.18.6 Remove the tie strap securing the small diameter flex tubing to the hose barb on the flow regulator assembly, and disconnect the tubing.

4.18.7 Un-screw the retaining ring holding the regulator to its mounting bracket, and remove the regulator.

4.18.8 Install the replacement regulator in the mounting bracket and tighten the mounting ring.

4.18.9 Connect the two compression fittings to the regulator.

4.18.10 Reattach the small diameter flex tubing previously removed from the regulator assembly and secure the connection with a tie strap.

4.18.11 Remove the prop from the front of the monitor box, and return the box to its normal position.

4.18.12 Replace the screws holding the monitor box to the ventilator box.

4.18.13 Join the ventilator switch in-line connector, and replace the front panel of the ventilator box.

4.18.14 Perform the PMS Procedure given in Section 6.

VENTILATOR BOX TOP VIEW

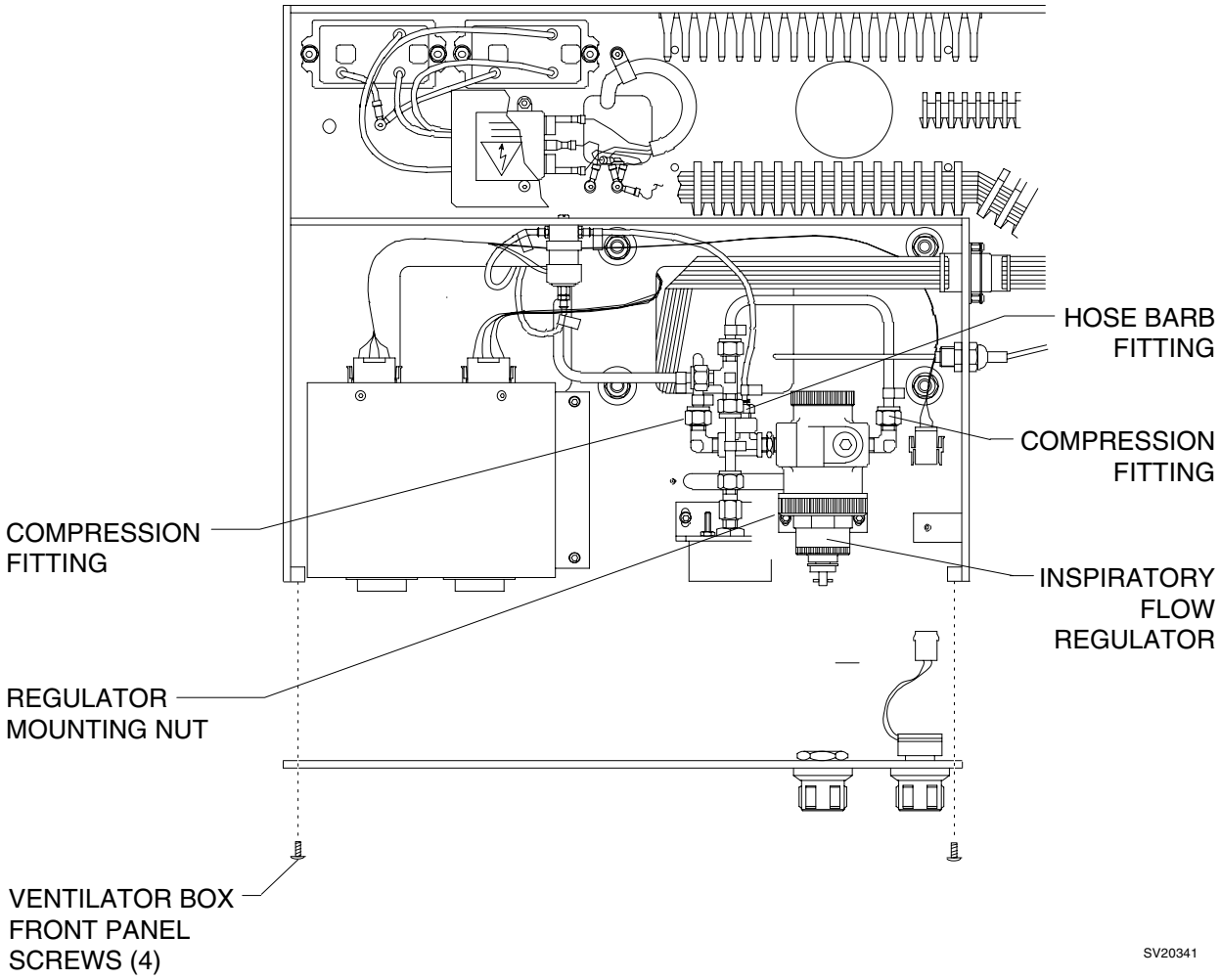



**Figure 4-18: INSPIRATORY FLOW REGULATOR**

## 4.19 Ventilator Bellows Valve and Guide Assembly (AV-E Ventilator)

The ventilator bellows valve and guide assembly is located in the bellows box on the left side of the machine. Access to the valve and guide assembly requires that the front panel, the bellows cannister, and the upper bellows plate be removed from the bellows box. The monitor box will also need to be raised for access to connections inside the ventilator box. Figure 4-19 shows the valve and guide assembly arrangement, and the tubing connections for assemblies with either a Humphrey or a Clippard valve.

4.19.1 Set the System Power switch to STANDBY, remove AC power from the machine, and disable all circuit breakers.

4.19.2 Close all cylinder valves, and disconnect the pipeline hoses from the machine.

4.19.3 Press the $O_2$ FLUSH button to relieve pressure from the system.

4.19.4 Adjust the TIDAL VOLUME knob to fully extend the volume indicator to its minimum setting.

4.19.5 Disconnect the bellows hose and the scavenger hose from the bellows assembly. Loosen the wingnuts and remove the bellows assembly and the canister.

4.19.6 Remove the canister from the bellows box by pulling it downward.

4.19.7 Remove the screws holding the front panel and tidal volume adjustment knob, and remove the panel. The knob assembly remains with the panel. On machines with a two-piece panel, remove the angle plate above the knob panel.

4.19.8 Remove the screws holding the monitor box to the ventilator box.

WARNING: Two people are required to perform the remaining portion of the procedure.

4.19.9 Raise the front of the monitor box chassis approximately four inches, and prop the box open.

WARNING: Ensure that AC power is removed from the machine before raising the monitor box. Failure to observe this precaution may cause injury by electric shock.

4.19.10 Remove the bellows guide by unscrewing its stem from the bellows adjustment rod.

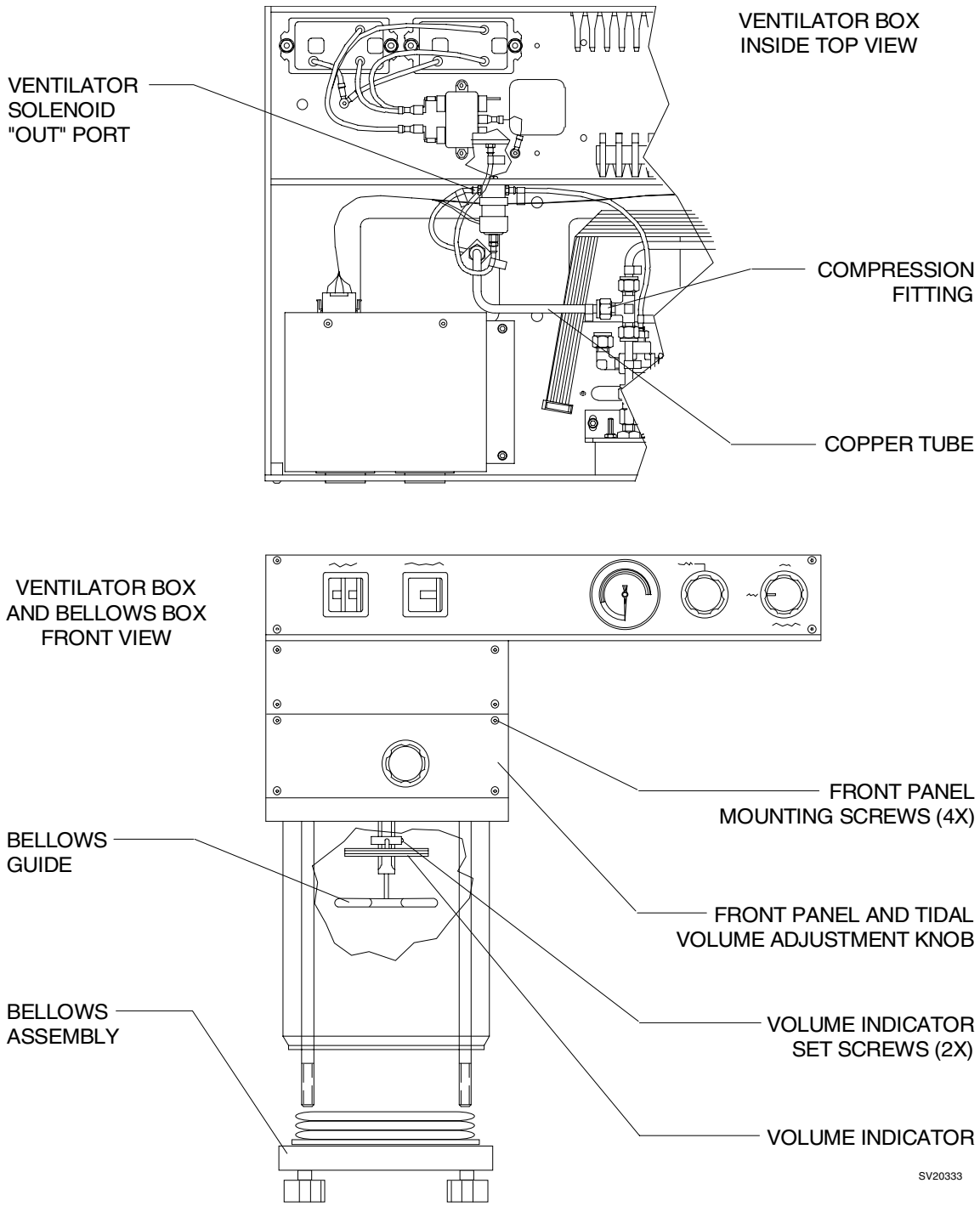



**Figure 4-19: TIDAL VOLUME ADJ. & VALVE CASE ASSEMBLY**

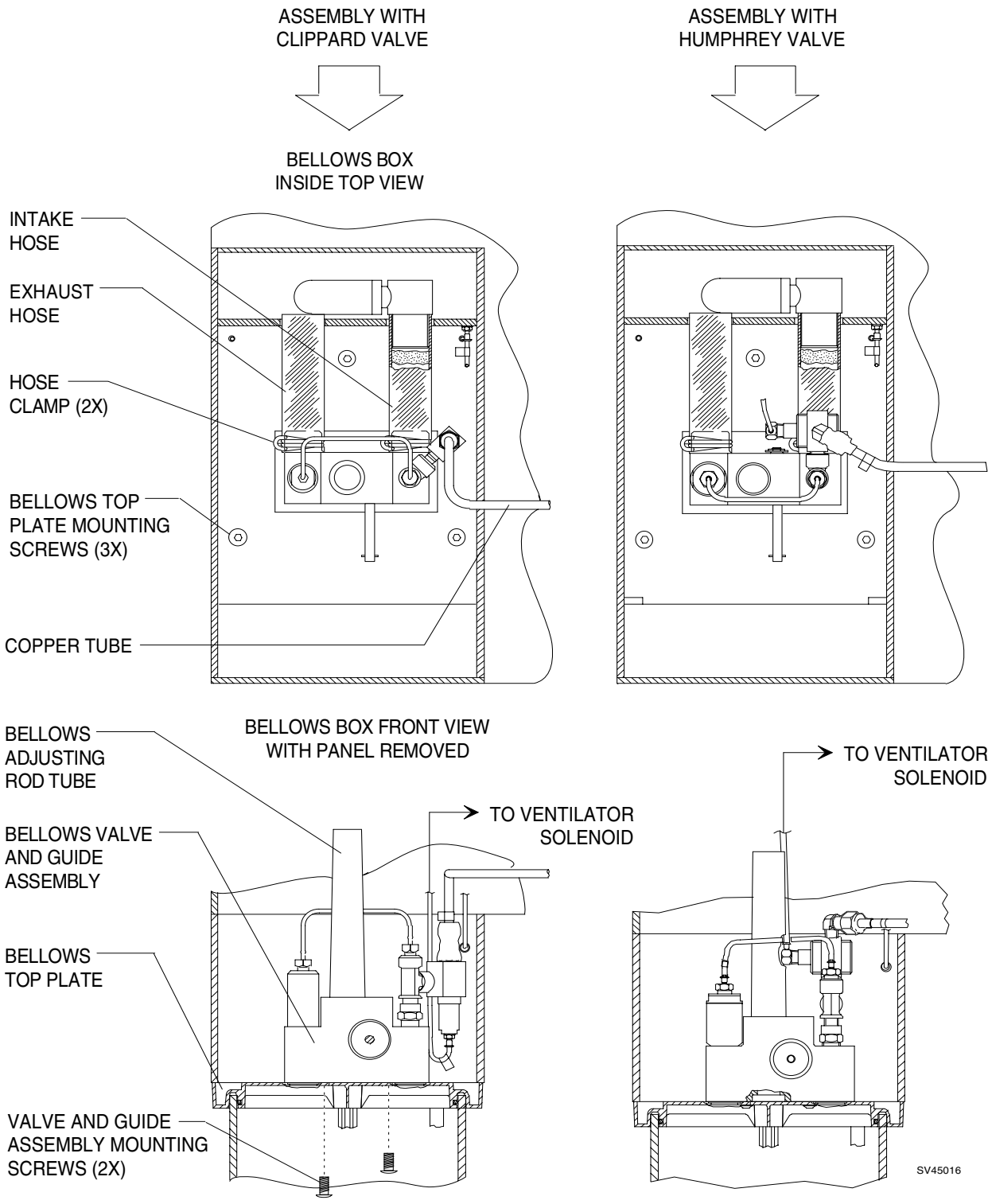



**Figure 4-19: TIDAL VOLUME ADJ. & VALVE CASE ASSEMBLY (continued)**

4.19.11 Remove the volume indicator from the bellows adjustment rod by loosening its two set screws. Note the position of the indicator on the rod so that it can be reassembled in the same manner.

4.19.12 Remove the screws securing the muffler access panel at the rear of the bellows box, and remove the panel.

4.19.13 Remove the muffler/silencer (white tube) from the intake flange at the interface wall by turning the muffler counter-clockwise.

4.19.14 Disconnect the press-on clamp and small diameter tubing from the left side hose barb on the ventilator solenoid valve (port labeled "out").

4.19.15 Disconnect the compression fitting at the outboard end of the copper tube from the valve case assembly.

4.19.16 Unscrew the bellows adjustment rod tube from the top of the assembly. Do not misplace the spacer ring.

4.19.17 Pull the bellows adjustment rod up.

4.19.18 Remove the two screws securing the valve case and guide assembly to the bellows top plate.

NOTE: Be careful not to misplace the two O-rings and the spacer ring under the valve case assembly.

4.19.19 Pull both large diameter tubes forward until they clear the muffler housing interface wall.

4.19.20 Rotate the valve case and guide assembly as needed in order to withdraw it from the bellows box.
CAUTION: Do not damage any of the fittings or small hose barbs on the assembly during its removal.

4.19.21 Transfer the large diameter tubing and hose clamps to the intake and exhaust ports on the replacement valve case and guide assembly.

4.19.22 Carefully position the replacement valve case and guide assembly in the bellows box, with the copper tube extending up into the ventilator box, and with the intake and exhaust hoses correctly positioned in the muffler housing interface wall.

4.19.23 Secure the valve case assembly to the bellows top plate with the two screws that were previously removed. Be sure that the spacer ring and the two O-rings in the bellows top plate are properly seated.

4.19.24 Connect the copper tube to the tee fitting in the ventilator box.

4.19.25 Install the spacer ring and bellows adjustment rod tube at the top of the valve case and guide assembly.

4.19.26 Attach the small diameter tubing from the miniature actuator to the left side hose barb on the ventilator solenoid valve (port labeled "out"), and secure the connection with a press-on clamp.

NOTE: After the connection is made, ensure that there are no kinks or sharp bends in the tubing.

4.19.27 Reattach the muffler/silencer to the intake flange at the muffler housing interface, and reattach the rear access panel using the screws that were previously removed.

4.19.28 Install the volume indicator on the bellows adjustment rod in the same position as before disassembly, and tighten its two setscrews.

4.19.29 Install the bellows guide by screwing its stem into the bellows adjustment rod. Secure it with #222 (purple) Loctite.

4.19.30 Remove the prop from the monitor box and carefully lower it into position. Replace the screws holding the monitor box to the ventilator box.

4.19.31 Place the bellows box front panel into position, ensure that the slot in the knob assembly is correctly aligned with the drive pin on the bellows adjustment shaft, and install the four screws holding the front panel to the machine.

4.19.32 Replace the bellows assembly and tighten the wingnuts holding it in place. Connect any hoses that were previously removed from the bellows assembly.

4.19.33 Reconnect the pipeline hoses and AC power cord, and reset all circuit breakers.

4.19.34 Perform the PMS Procedure given in Section 6.

## 4.20 Ventilator Bellows Valve and Guide Assembly with Pressure Limit Control (AV-2 Ventilator)

The Ventilator Bellows Valve and Guide Assembly, and the Pressure Limit Control are located in the bellows box on the left side of the machine. Access to the components requires removal of the bellows box front panel, and removal of the upper bellows support plate from the bellows box. Figure 4-20 shows the pneumatic connections and the mounting arrangement of the components.

4.20.1 Set the System Power switch to STANDBY, and remove AC power from the machine.

4.20.2 Close all cylinder valves, and disconnect the pipeline hoses from the machine.

4.20.3 Press the $O_2$ Flush button to relieve pressure from the system.

4.20.4 Adjust the TIDAL VOLUME control to raise the volume indicator to its maximum setting.

4.20.5 Disconnect the breathing hose and the scavenger hose from the bellows assembly. Loosen the wing nuts and remove the bellows assembly.

4.20.6 Remove the canister from the bellows box by pulling it downward.

4.20.7 Unscrew the bellows guide from the adjustment rod.

4.20.8 Loosen the set screws on the tidal volume indicator (note the position of the indicator on the adjustment rod so that it can be reassembled in the same position) and remove the indicator.

4.20.9 Remove the screws holding the bellows box front panel and knob assemblies, and remove the panel.

4.20.10 Loosen the rear support plate screw, and remove the two front support plate screws.

4.20.11 Pull the support plate forward, then lower it to a point where the tubing connections are accessible.

4.20.12 Disconnect the large diameter tubing from the venturi, and the small diameter tubing from the auto-ranging valve.

4.20.13 Carefully remove the assembly from the machine. Mounting screws for the adjustable pressure limit control and the valve case assembly are shown in the illustration.

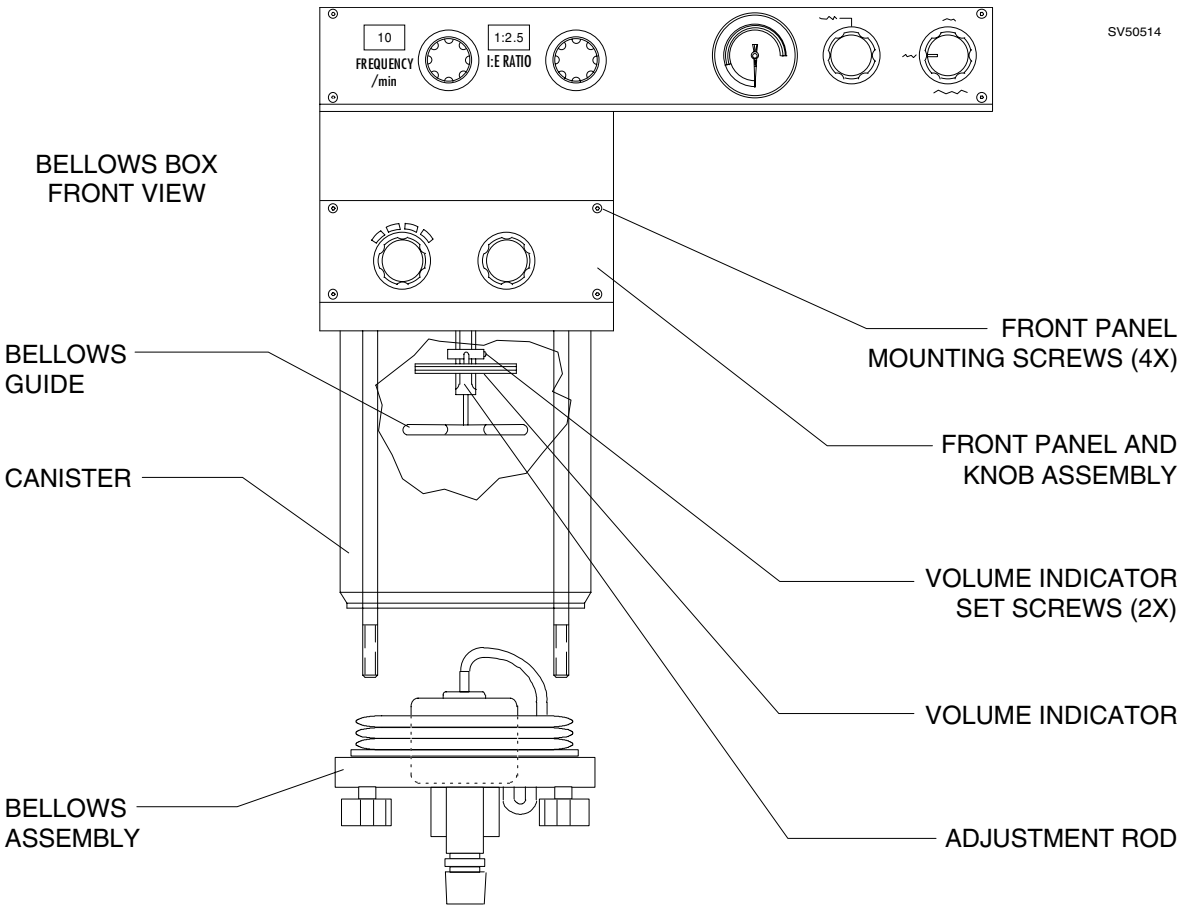



**Figure 4-20: TIDAL VOLUME ADJ. & VALVE CASE ASSEMBLY**

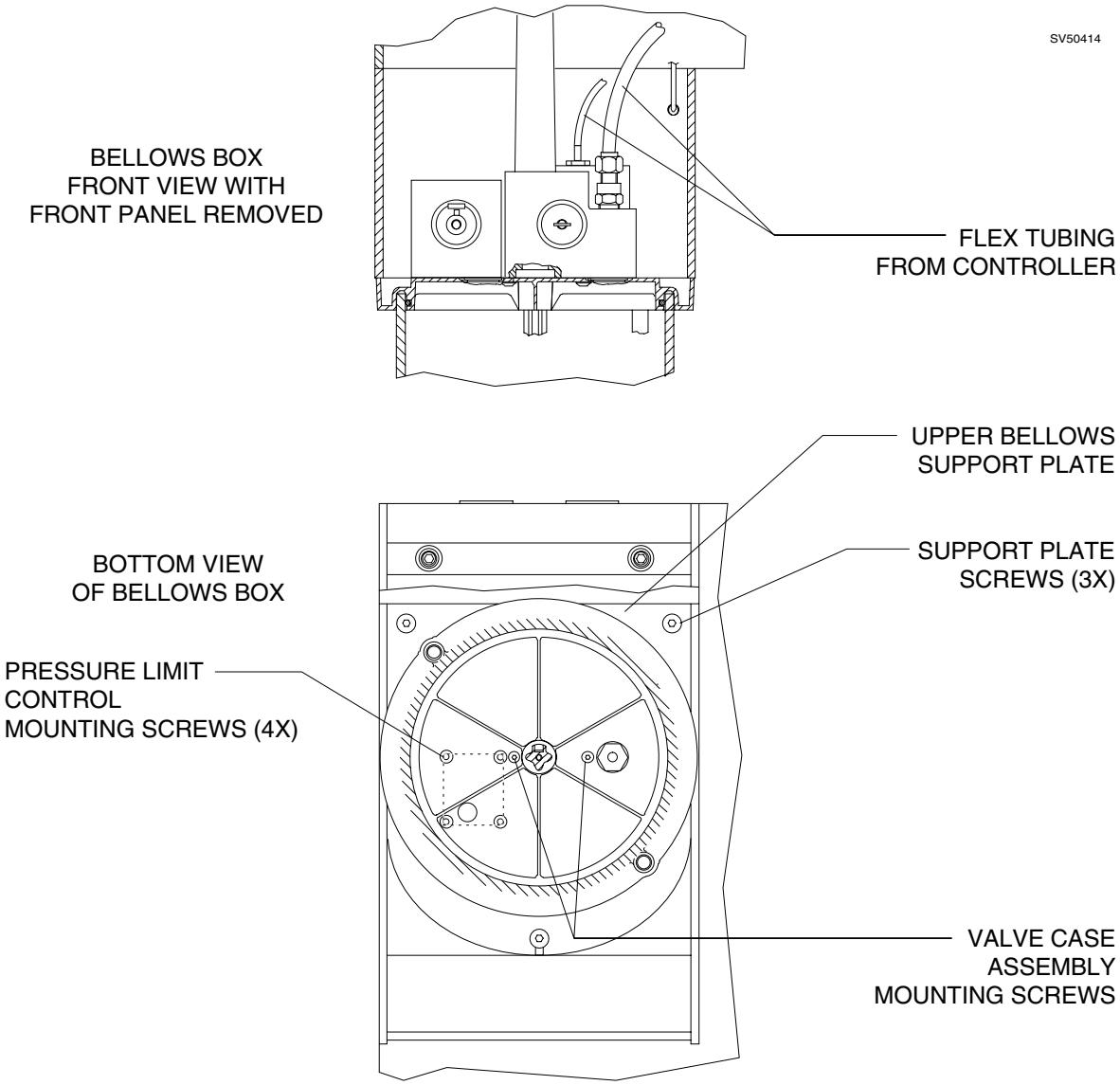



**Figure 4-20: TIDAL VOLUME ADJ. & VALVE CASE ASSEMBLY (continued)**

NOTE: If components are removed from the support plate, be sure that any spacers and O-rings are correctly positioned during reinstallation.

4.20.14 Following component replacement, position the support plate in the bellows box and reconnect the large and small diameter tubing that was previously removed.

4.20.15 Slide the support plate up and to the rear until it is seated properly in the bellows box.

4.20.16 Reinstall the two front support plate screws, and tighten the rear support plate screw.

4.20.17 Install the volume indicator on the bellows adjustment rod in the same position as before disassembly, and tighten its two setscrews.

4.20.18 Install the bellows guide by screwing its stem into the bellows adjustment rod.

4.20.19 Place the bellows box front panel into position, ensure that the slots in the knob assemblies are correctly aligned with their drive pins on the bellows adjustment and pressure limit control shafts, and reinstall the screws holding the front panel to the machine.

4.20.20 Replace the bellows canister; ensure that its markings are facing forward.

4.20.21 Replace the bellows assembly and tighten the wing nuts holding it in place.

4.20.22 Reconnect any hoses that were previously removed from the bellows assembly.

4.20.23 Reconnect the pipeline hoses and AC power cord.

4.20.24 Perform the PMS Procedure given in Section 6.

## 4.21 Alarm Channel (without oxygen supply pressure alarm switch)

Replacement of the alarm channel requires removal of the upper flowmeter front cover plate. (On later models the vapor box cover plate is extended to also cover the flowmeter shield and alarm channel.) The alarm channel assembly is held in place by two screws from the back. Figure 4-21 shows a rear view of the assembly and its connections.

4.21.1 Disconnect the pipeline hoses and close all cylinder valves.

4.21.2 Press the $O_2$ Flush valve to drain oxygen pressure from the system.

4.21.3 Set the System Power switch to STANDBY and remove AC power from the machine.

4.21.4 Remove the screws holding the rear cover, and remove the cover.

4.21.5 Remove the screws holding the table top, and lift out the table top.

CAUTION: The circuit board contains static sensitive devices. Use ESD protection when handling this assembly.

4.21.6 Disconnect the cables from J1, J2, J3 and J4 on the alarm circuit board.

WARNING: Ensure that AC power is removed from the machine before disconnecting the cables. Failure to observe this precaution may cause injury by electric shock.

4.21.7 Disconnect the two compression fittings at the system power switch valve.

4.21.8A Early models: Remove the two screws (from the back) holding the angled cover plate at the top of the channel. Hold the cover plate as the screws are removed from the back.

4.18.8B Later models (without the $O_2/N_2O$ ratio alarm lamp): Remove the six screws holding the flowmeter shield and vapor box cover, and remove the panel.

4.21.9 Feed the flowmeter lights wire harness through the hole at the top of the alarm channel.

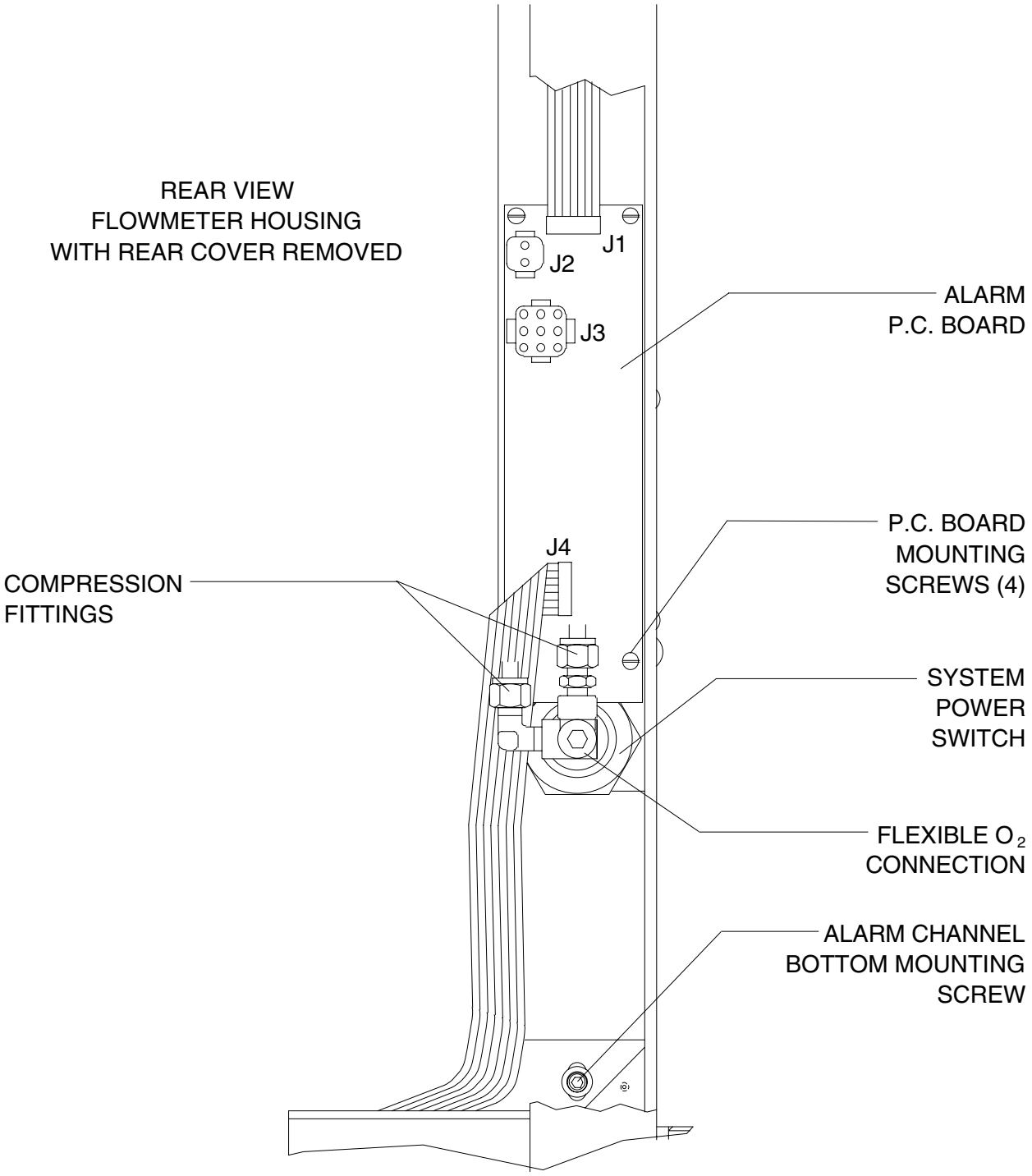



**Figure 4-21: ALARM PANEL AND SYSTEM POWER SWITCH**

4.21.10 Remove the alarm channel mounting screws. If the machine does not have an auxillary $O_2$ flow meter, skip the next two steps.

4.21.11 If the machine is equipped with an auxillary $O_2$ flow meter,pull the alarm channel forward far enough to gain access to the system power switch valve, cut the tie-wrap clamp on the flexible tube at the valve, and remove the tube from the valve.

4.21.12 Connect the flexible tube to the system power switch valve on the replacement alarm channel and install a new tie-wrap clamp.

4.21.13 Set the replacement alarm channel in position and connect the two compression fittings to the system power switch valve. Do not tighten the fittings yet.

4.21.14 Reinstall the alarm channel mounting screws.

4.21.15 Feed the flowmeter lights wire harness connector through the hole at the top of the alarm channel.

4.21.16 Reinstall the cover plate at the top of the channel and secure it with the hardware that was previously removed.

4.21.17 Tighten the two compression fittings at the system power switch valve and perform the following leak test:

4.21.17.1 Open the oxygen cylinder valve and allow the pressure to stabilize.

4.21.17.2 Close the oxygen cylinder valve.

4.21.17.3 The pressure should not drop more than 50 psi in two minutes. (The cylinder pressure must be at least 1000 psi for this test.)

4.21.18 Connect the cables that were previously removed from J1, J2, J3 and J4 on the alarm circuit board.

4.21.19 Replace the rear cover and its retaining screws.

4.21.20 Replace the table top and its mounting screws.

4.21.21 Connect the pipeline hoses and restore AC power to the machine.

4.21.22 Perform the PMS Procedure given in Section 6.

## 4.22 Alarm Channel and Oxygen Supply Pressure Alarm Switch

The alarm channel assembly includes the oxygen supply pressure alarm switch, the alarm circuit board, and the system power switch. Whenever the alarm channel is replaced, the oxygen supply pressure alarm switch must be tested to ensure that its operating point is set correctly. Removal of the alarm channel requires removal of the upper flowmeter and vapor box cover plate, and removal of the flowmeter housing rear cover. The alarm channel assembly is held in place by two screws from the back. Figure 4-22 shows a rear view of the assembly and its connections.

4.22.1 Disconnect all pipeline hoses and set the System Power switch to ON.

4.22.2 Close all cylinder valves except the $O_2$ valve.

4.22.3 Set the oxygen flow to 5 liters per min.

4.22.4 Open the other gas flow control valves to drain pressure from the system.

4.22.5 Close the $O_2$ cylinder valve and the $O_2$ flow control valve. Press the $O_2$ Flush valve to drain oxygen pressure from the system.

4.22.6 Set the System Power switch to STANDBY, and remove AC power from the machine.

4.22.7 Disable the circuit breakers on the power supply by pulling out each button with a knife or sharp object.

4.22.8 Remove the six screws holding the flowmeter shield and vapor box front coverpanel, and pull the panel forward approximately ½ inch.

4.22.9 Remove the screws holding the flowmeter housing rear cover, and remove the cover.

4.22.10 Remove the screws holding the table top, and lift out the table top.

4.22.11 Disconnect the cables from J1, J2, J3 and J4 on the alarm circuit board.

4.22.12 Disconnect the compression fitting on the $O_2$ line nearest to the oxygen supply pressure alarm switch.

4.22.13 Disconnect the remaining two $O_2$ lines at the top and bottom of the tee fitting.

4.22.14 If the machine is equipped with an auxiliary $O_2$ flowmeter, cut the tie strap on its flexible line and carefully remove the flex line from the hose barb.

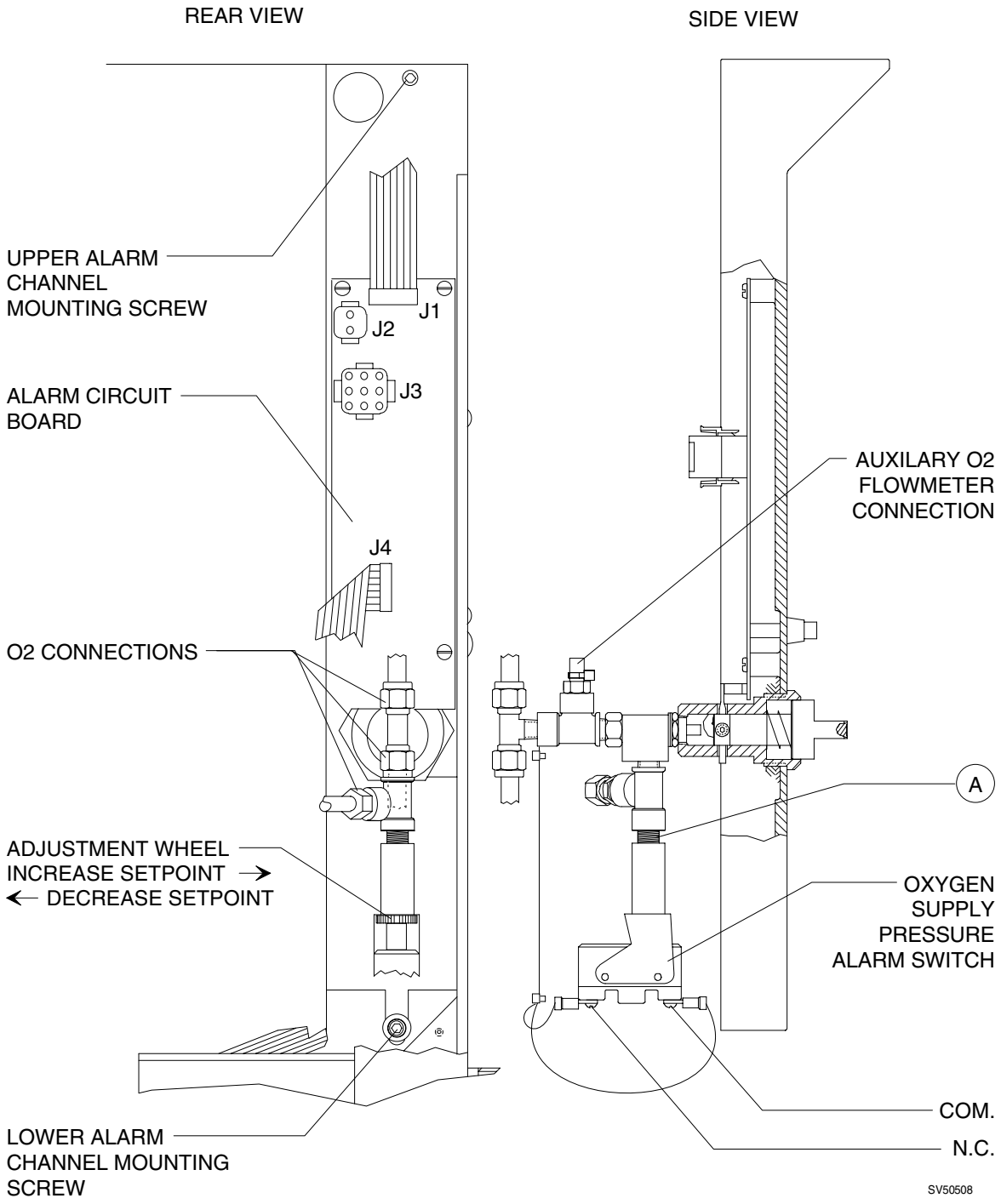



**Figure 4-22: ALARM CHANNEL AND OXYGEN SUPPLY PRESSURE ALARM SWITCH**

4.22.15 From the back of the flowmeter housing, remove the upper and lower alarm channel mounting screws.

4.22.16 At the front of the machine, pull the alarm channel assembly forward, and feed the flowmeter lights wire harness through the hole at the top of the alarm channel.

4.22.17 Disconnect the orange and orange/white wires from the oxygen supply pressure alarm switch.

4.22.18 The following steps apply to replacement of the oxygen supply pressure alarm switch. If the entire alarm channel assembly is being replaced, skip the next two steps.

4.22.19 Remove the alarm switch from the assembly at point Ⓐ as shown in the illustration.

4.22.20 Install the replacement alarm switch with sealing tape on the threads, and ensure that the switch is oriented on the assembly as shown in the illustration.

4.22.21 Connect the orange and orange/white wires to the replacement switch in the same manner as the original.

4.22.22 Feed the flowmeter lights wire harness through the hole at the top of the alarm channel, and set the alarm channel assembly into place.

4.22.23 Install the upper and lower alarm channel mounting screws.

4.22.24 If applicable, reconnect the flex line from the auxiliary $O_2$ flowmeter and install a new tie strap at the hose barb.

4.22.25 Reconnect the the $O_2$ lines, and tighten the three compression fittings.

4.22.26 Reconnect the cables to J1, J2, J3 and J4 on the alarm circuit board.

4.22.27 Reinstall the front flowmeter and vapor box cover with the six screws that were previously removed.

4.22.28 Pull the writing or keyboard tray out to its fully extended position.

4.22.29 Locate the tee fitting in the ¼ in. diameter output line of the $O_2$ regulator and remove the plug from the tee fitting.

4.22.30 Connect a dedicated $O_2$ test gauge to the tee fitting.

4.22.31 Connect AC power to the machine and enable the circuit breakers by pressing their buttons in.

4.22.32 Open an oxygen cylinder valve and turn the System Power switch to ON.

4.22.33 Set the oxygen flow to five liters per minute.

4.22.34 Close the oxygen cylinder valve.

4.22.35 As the pressure drops, the $O_2$ SUPPLY alarm should activate when the pressure is between 40 and 34 psi as shown on the test gauge.

4.22.36 If the alarm activates when the pressure is below 34 psi or above above 40 psi, turn the adjustment wheel (see illustration), repeat the test and adjust as necessary to bring the set point into the correct range.

4.22.37 Turn the System Power switch to STANDBY.

4.22.38 Disconnect the test gauge and replace the plug in the regulator line tee fitting.

4.22.39 Replace the table top and its retaining screws.

4.22.40 Replace the flowmeter housing rear cover and its retaining screws.

4.22.41 Connect the pipeline hoses.

4.22.42 Perform the PMS Procedure given in Section 6.

## 4.23 Caster

Each caster is retained by a set screw in the side of the lower frame rail as shown in Figure 4-23. Caster replacement requires that the machine be tilted to provide enough clearance for the caster stem to be withdrawn from the bottom of the frame rail.

WARNING: Do not tilt the machine more than 10 degrees or raise the casters more than 3½ inches from the floor. Failure to observe this precaution may result in a tip-over, causing personal injury. Vaporizers containing anesthetic agent may also be damaged.

4.23.1 Obtain a brace capable of supporting one side of the machine with its casters two to three inches from the floor.

4.23.2 Remove all unsecured equipment and accessories from the machine.

4.23.3 Lock the front casters.

4.23.4 Using at least two people, tilt the machine until the casters on one side are raised two to three inches from the floor, and position the support brace under the frame rail between the front and back casters.

4.23.5 Remove the plastic cap in the side of the frame rail to provide access to the caster stem set screw.

4.23.6 Loosen the set screw and remove the caster.

4.23.7 Insert the replacement caster into the frame and hold it in its seated position.

4.23.8 Tighten the caster stem set screw and replace the plastic cap in the frame rail.

4.23.9 Using at least two people, tilt the machine, remove the support brace and carefully lower the machine to the floor.

4.23.10 Check for proper operation of the caster and ensure that the front casters lock properly.

4.23.11 Perform the PMS Procedure given in Section 6, including a vaporizer calibration verification.

4.23.12 Replace any unsecured equipment and accessories that were previously removed.

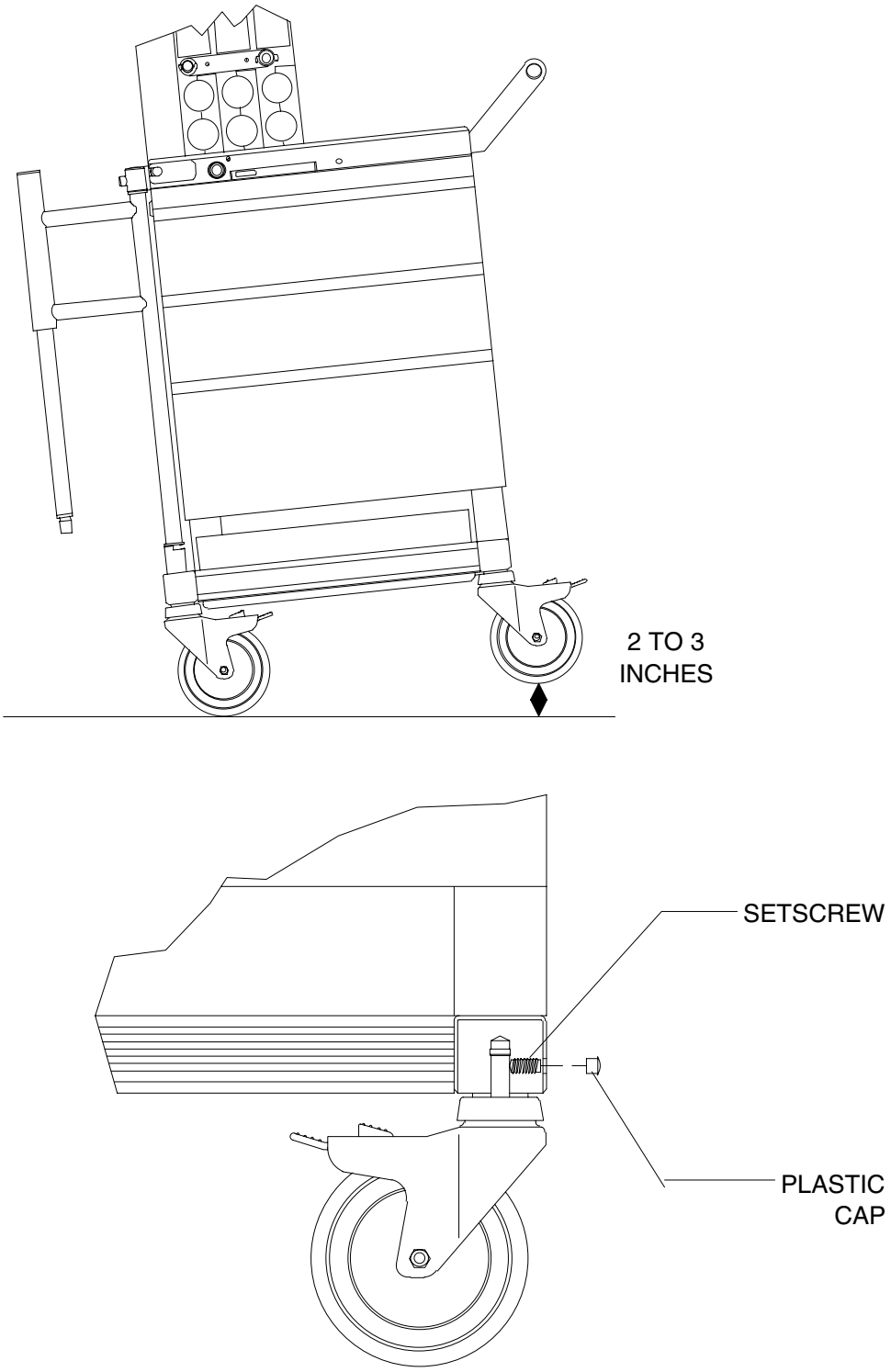



**Figure 4-23: CASTER REPLACEMENT**

## 4.24 Battery

The AC backup batteries are located in a compartment below the bottom cabinet drawer. Access to the batteries requires removal of the battery compartment cover. Figure 4-24 shows the battery mounting arrangement and their connections.

4.24.1 Set the System Power switch to STANDBY and remove AC power from the machine.

4.24.2 Remove the bottom drawer from the cabinet by pulling it out to its fully extended position and lifting it from the tracks.

4.24.3 Remove the four screws holding the battery compartment cover, and remove the cover.

WARNING: Ensure that AC power is removed from the machine before opening the battery compartment cover. Failure to observe this precaution may cause injury by electric shock.

4.24.4 Disconnect the wires from the battery terminals. Note the battery wire arrangement and wire colors so that the wiring can be re-connected in the same manner.

4.24.5 Remove the screw holding the battery retainer bar, and remove the retainer bar.

4.24.6 Lift the batteries from the compartment.

4.24.7 Install the replacement batteries in the compartment, making sure that the battery terminals are oriented correctly as shown in the illustration.

4.24.8 Install the battery retainer bar by placing its tab through the slot in the right side of the compartment, and replacing the retainer screw at the left side of the bar.

4.24.9 Connect the wiring to the battery terminals.

CAUTION: Be sure that the wiring is connected to the battery terminals in the correct order and polarity.

4.24.10 Replace the battery compartment cover.

4.24.11 Replace the bottom drawer.

4.24.12 Restore AC power to the machine and perform the PMS Procedure given in Section 6.

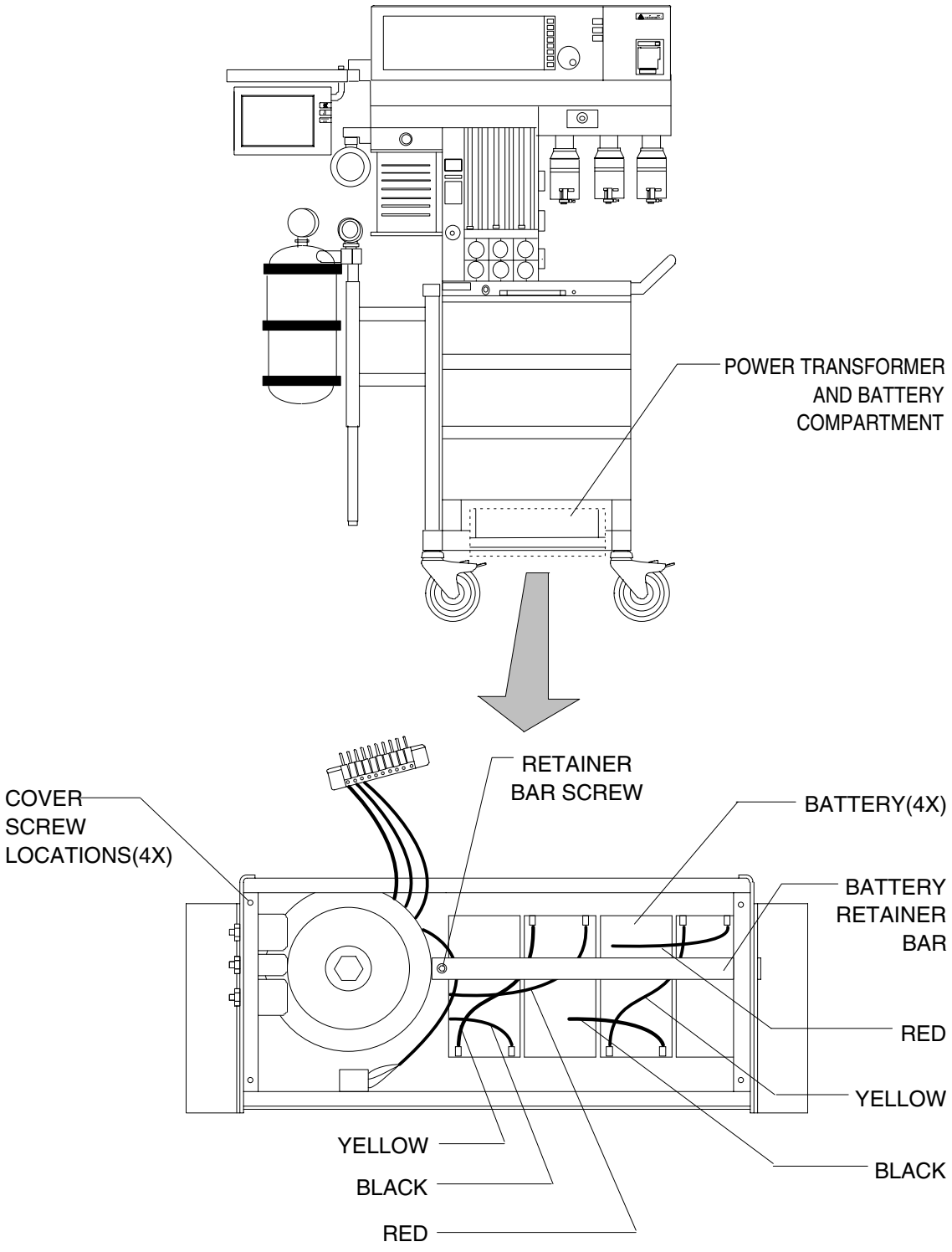



**Figure 4-24: BATTERIES**

## 4.25 Power Supply Circuit Board

The power supply circuit board assembly is located in a compartment at the back of the machine. Access to the circuit board requires removal of the compartment cover. Figure 4-25 shows the location of the board and its mounting arrangement.

4.25.1 Set the System Power switch on the front panel to the STANDBY position and remove AC power from the machine.

4.25.2 Close the valves on any cylinders that are mounted on the back of the machine. Remove the cylinders and store them in a safe place.

4.25.3 Remove the ten screws holding the cover over the power supply circuit board compartment.

4.25.4 Disconnect cables from J1 through J6 on the circuit board.

4.25.5 Loosen the three captive mounting screws holding the circuit board assembly to the compartment, and remove the assembly.

4.25.6 Position the replacement circuit board assembly over the mounting holes and fasten the mounting screws.

4.25.7 Connect the cables to J1 through J6.

4.25.8 Restore power to the machine and run the power supply diagnostic test given in Section 2 to verify that the voltages are within allowable tolerances.

4.25.9 Replace the cover over the power supply circuit board compartment.

4.25.10 Replace the cylinder(s) that were previously removed from the back of the machine.

4.25.11 Perform the PMS Procedure given in Section 6.

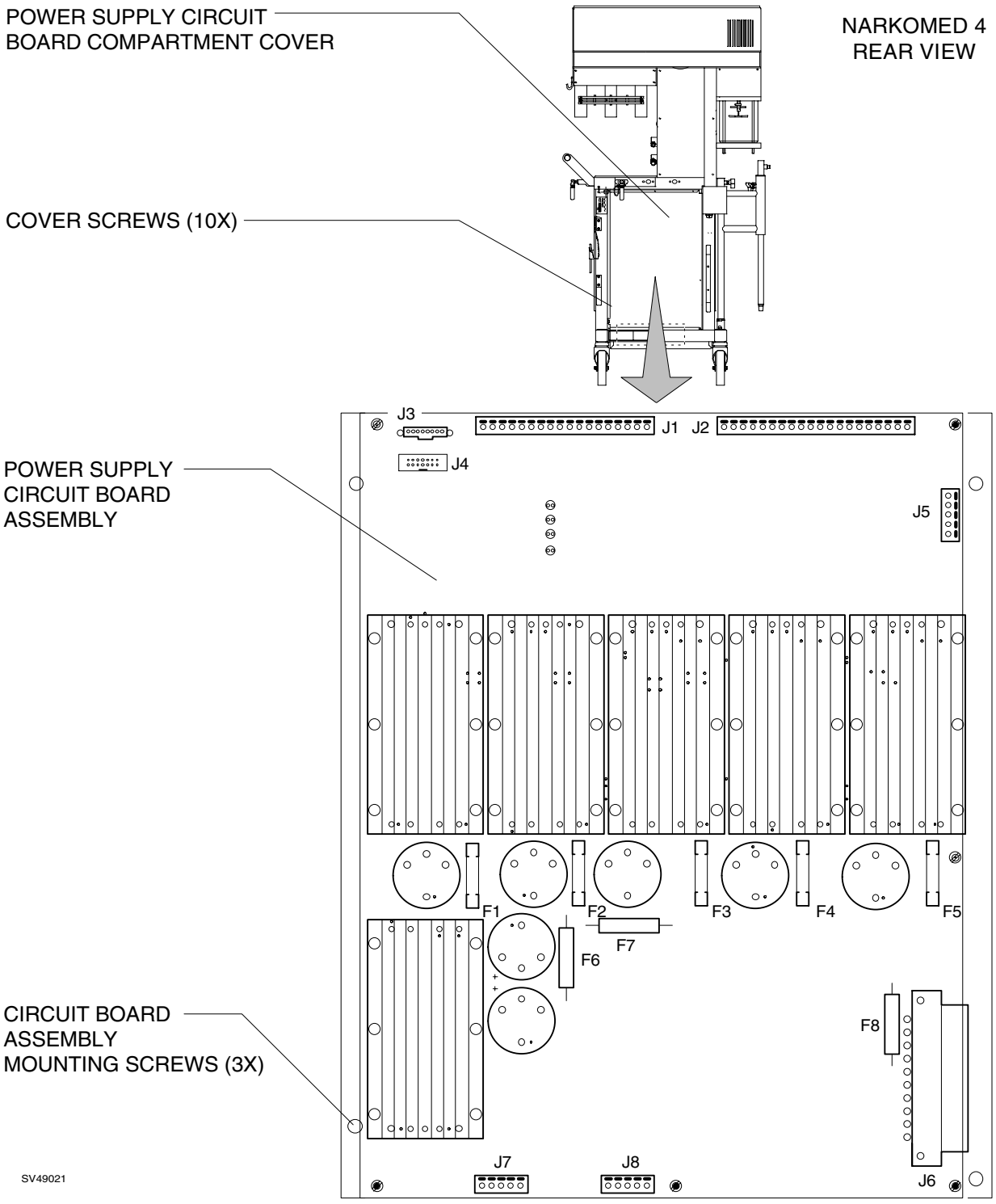



**Figure 4-25: POWER SUPPLY CIRCUIT BOARD**

## 4.26 Processor Boards

The processor boards are contained in a card cage that is part of a backplane assembly located behind the display screens in the monitor box. The monitor box cover must be removed to gain access to the backplane assembly. Figure 4-26 shows the arrangement of the processor boards in the backplane. The upper board is the primary processor and the lower board is the backup processor.

4.26.1 Set the System Power switch on the front panel to the STANDBY position and remove AC power from the machine.

CAUTION: Do not plug or unplug remote display with power applied.

4.26.2 Remove all connections from the patient interface panel on the left side of the monitor box.

4.26.3 Remove the disposable reservoir from its holder.

4.26.4 Remove the six screws holding the monitor box cover, and carefully lift the cover from the monitor box.

CAUTION: The processor boards contain static sensitive devices. Use ESD protection when handling these boards.

4.26.5 Open the board extractors and carefully withdraw the board assembly from the card cage.

4.26.6 Slide the replacement processor board assembly into the card cage and close the board extractors to ensure that the board is seated properly in the backplane connectors.

NOTE: Ensure that the replacement processor board is electrically compatible with the existing front bezel assembly. Refer to the part number combinations listed in Section 8.

NOTE: Both processor boards must have the same part number and revision level for the machine to work properly.

4.26.7 Restore power to the machine and run the diagnostic test given in Section 2 to verify that the replacement board is working properly.

4.26.8 Set the System Power switch on the front panel to the STANDBY position and remove AC power from the machine.

4.26.9 Replace the monitor box cover and restore all connections to the patient interface panel. Replace the disposable reservoir.

4.26.10 Perform the PMS Procedure given in Section 6.

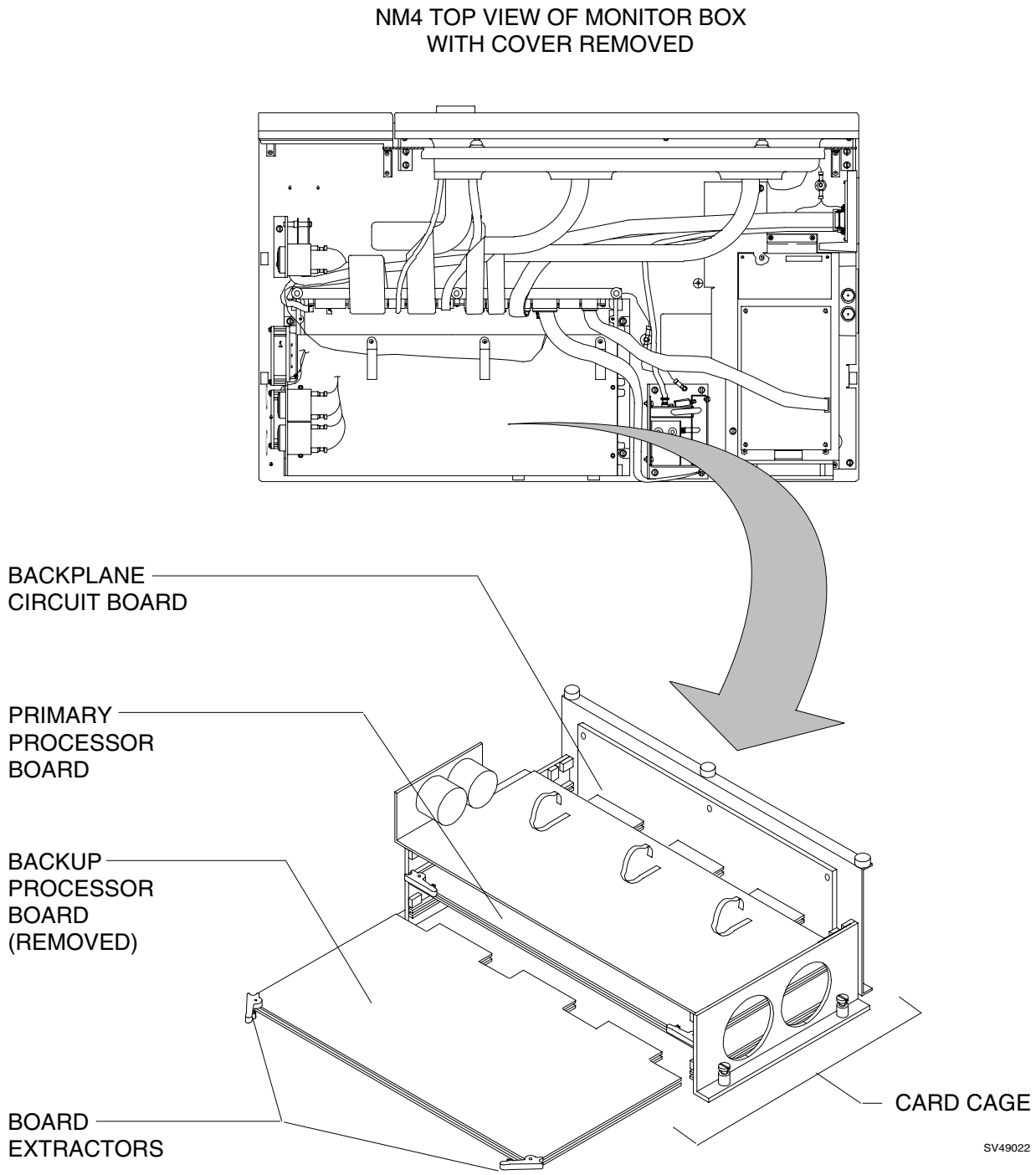



**Figure 4-26: PROCESSOR BOARDS**

## 4.27 Serial Interface Assembly

The serial interface assembly containing the external communication ports is located on the back of the machine and is mounted on the underside of the monitor box. Figure 4-27 shows the circuit board connections and the mounting of the board in its housing.

4.27.1 Set the System Power switch on the front panel to the STANDBY position and remove AC power from the machine.

4.27.2 Disconnect any external cables from the A, B, PRINTER, C and D ports.

4.27.3 Loosen the four captive screws holding the serial interface housing to the underside of the monitor box.

CAUTION: The serial interface circuit board contains static sensitive devices. Use ESD protection when handling this card.

4.27.4 Disconnect the ribbon cable from J6 on the circuit board.

4.27.5 Remove the ground wire at terminal E1 on the circuit board.

4.27.6 Remove the two screwlock connector nuts at each of the five interface connectors.

4.27.7 Remove the three screws holding the circuit board in its housing.

4.27.8 Install the replacement circuit board in the housing, and replace the two screwlock connector nuts at each of the five interface connectors. Connect the ground wire to terminal E1 and the ribbon cable to J6 on the circuit board.

4.27.9 Mount the serial interface assembly to the underside of the monitor box.

4.27.10 Connect any external cables that were previously removed from the serial interface ports.

4.27.11 Restore power to the machine and run the diagnostics test given in Section 2 to verify that the replacement circuit board is working properly.

4.27.12 Perform the PMS Procedure given in Section 6.

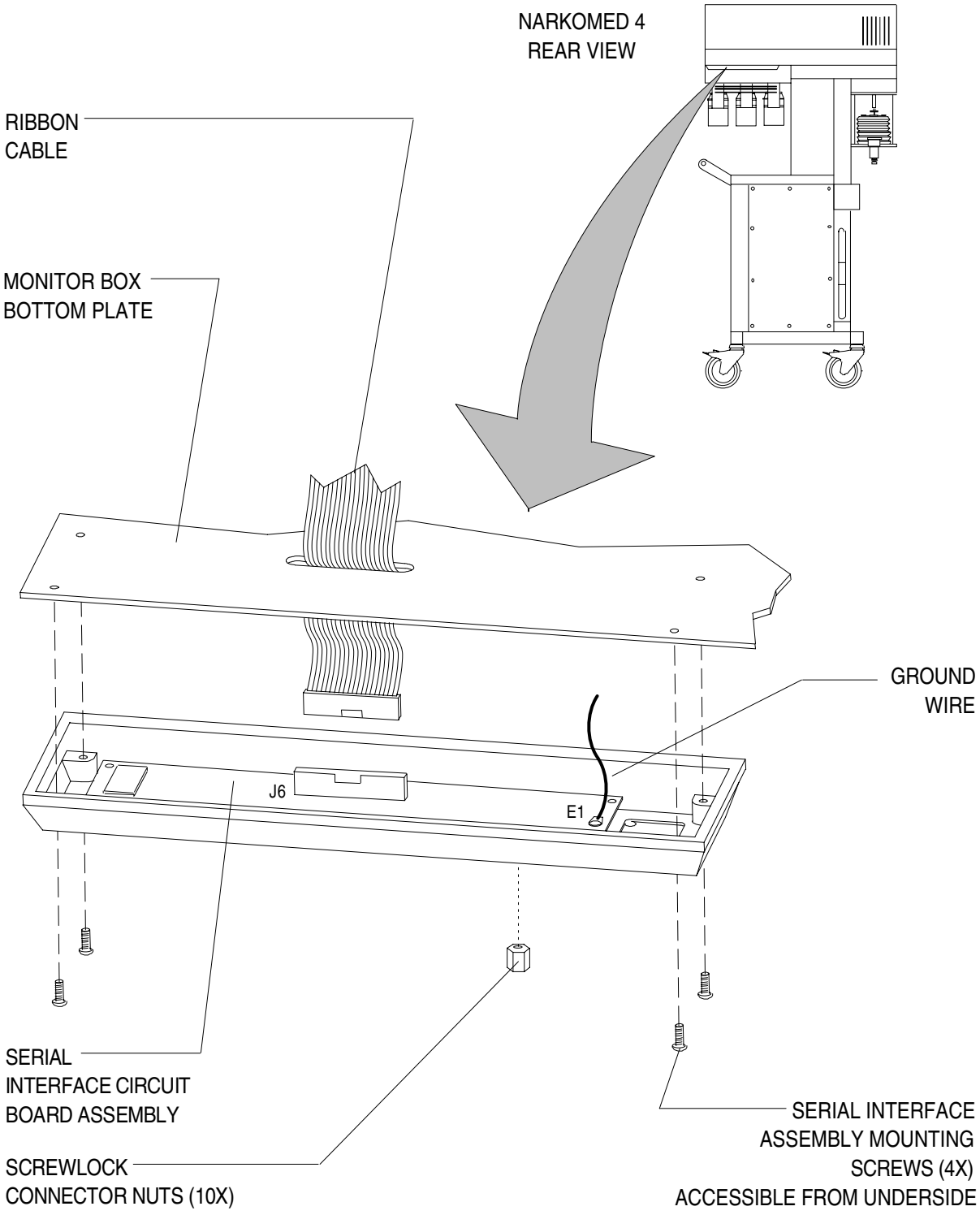



**Figure 4-27: SERIAL INTERFACE ASSEMBLY**

## 4.28 Backplane Circuit Board Assembly

The backplane circuit board is mounted on the front wall of the card cage assembly in the monitor box. Access to the circuit board requires removal of the processor boards, disconnecting all of the cables that are joined to the backplane, and removing the backplane support from the card cage. Refer to Figure 4-28 for general arrangement and mounting screw locations. The following procedure outlines the removal and replacement of the circuit board assembly.

4.28.1 Set the System Power switch on the front panel to the STANDBY position and remove AC power from the machine.

CAUTION: Do not plug or unplug remote display with power applied.

4.28.2 Disconnect the following items from the patient interface panel on the left side of the monitor box:

-Remote Display and Datagrip cables

-BP Cuff and BP Gauge lines

-Pulse Oximeter Sensor cable

4.28.3 Remove the disposable reservoir from its holder.

4.28.4 Remove the six screws holding the monitor box cover, and carefully lift the cover from the monitor box.

CAUTION: The backplane and processor circuit boards contain static sensitive devices. Use ESD protection when handling these boards.

4.28.5 Remove the processor boards from the backplane assembly.

4.28.6 Disconnect all of the cables that are joined to the backplane circuit board.

4.28.7 Loosen the captive mounting screws securing the card cage to the monitor chassis, and move the card cage assembly back far enough to gain access to the backplane support mounting screws.

4.28.8 Remove the four screws and washers securing the backplane support to the card cage.

4.28.9 Remove the 15 screws (three across the top and two at each of the six processor board connectors) securing the backplane PCB to the backplane support.

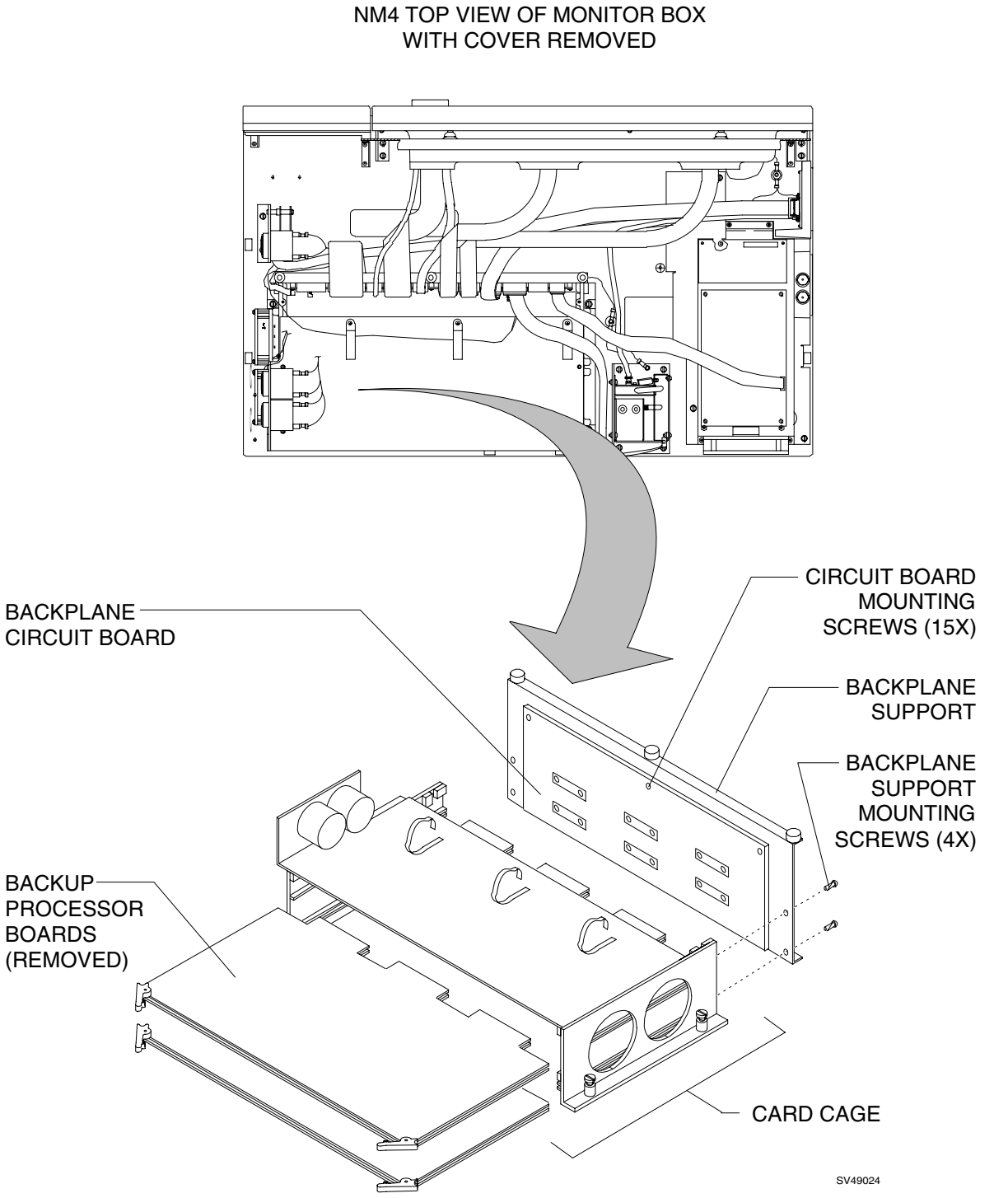



**Figure 4-28: CARD CAGE AND BACKPLANE ASSEMBLY**

4.28.10 Install the replacement backplane PCB on the backplane support with the 15 screws that were previously removed.

4.28.11 Reinstall the backplane support to the card cage with the four screws and washers that were previously removed.

4.28.12 Position the card cage in the monitor chassis, and tighten its captive mounting screws.

4.28.13 Backplane Jumper Configuration. Connect all of the backplane circuit board cables that were previously removed. Pay special attention to the jumpers located at JP19 on the backplane. Refer to the configuration table below to determine correct jumper configuration for the type of backplane being installed.

| Backplane Type | Jumper / position | Jumper removed | Jumper installed |
|---|---|---|---|
| 4110699 (see note below)<br>oldest style<br>jumper p/n: S4111720 | JP19 pins 1 to 4<br>JP19 pins 2 to 4<br>JP19 pins 3 to 4 | SCR-4112048<br>4600 Andros 4111411<br>without ORDM | SCR-4111129<br>4610 Andros 4112181<br>with ORDM |
| 4111881<br>intermediate<br>jumper p/n: 4109150 | JP19 pins 1 to 2<br>JP19 pins 3 to 4<br>JP19 pins 5 to 6 | SCR-4112048<br>4600 Andros 4111411<br>without ORDM | SCR-4111129<br>4610 Andros 4112181<br>with ORDM |
| 4112303<br>newest<br>jumper p/n: 4109150 | JP19 pins 1 to 2<br>JP19 pins 3 to 4<br>JP19 pins 5 to 6 | SCR-4112048<br>4600 Andros 4111411<br>without ORDM | SCR-4111129<br>4610 Andros 4112181<br>with ORDM |

NOTE: 4110699 Pin 4 is common. JP19 uses wire wrap connections; use caution to alter connections

4.28.14 Carefully slide the processor boards into the card cage and close the extractors to ensure that the boards are properly seated in the backplane connectors.

4.28.15 Restore power to the machine and run the diagnostics test given in Section 2 to verify that the replacement backplane is working properly.

4.28.16 Set the System Power switch on the front panel to the STANDBY position and remove AC power from the machine.

4.28.17 Replace the monitor box cover and connect the remote display cable, BP cuff and BP gauge lines and the oximeter sensor cable at the patient interface panel. Replace the disposable reservoir.

4.28.18 Perform the PMS Procedure given in Section 6.

## 4.29 Multispec Analyzer Assembly (Model 4600)

The multispec analyzer assembly is located in the left rear corner of the monitor box. Access to the assembly requires removal of the monitor box cover. The analyzer assembly contains several field-replaceable sub-assemblies. These are: the fan, the scrubber bottle, the Nafion tubing, the sample cell, and the pump, the HC11 PCB assembly, and the firmware EPROM. Replacement of the Nafion tubing, sample cell or pump requires that the multispec analyzer assembly be removed from the monitor box. Figure 4-29 shows the general arrangement of the multispec analyzer assembly and its connections.

NOTE: If the Model 4600 Multispec Analyzer Assembly is being replaced by a Model 4610, refer to Service Procedure 00117 for installation instructions.

4.29.1 Set the System Power switch on the front panel to the STANDBY position and remove AC power from the machine.

CAUTION: Do not plug or unplug remote display with power applied.

4.29.2 Disconnect the following items from the patient interface panel on the left side of the monitor box:

-Remote Display and Datagrip cables

-BP Cuff and BP Gauge lines

-Pulse Oximeter Sensor cable

4.29.3 Remove the disposable reservoir from its holder.

4.29.4 Remove the six screws holding the monitor box cover, and carefully lift the cover from the monitor box.

NOTE: The following procedure applies to replacement of the entire analyzer assembly. Procedures for replacement of sub-assemblies begin at Paragraph 4.29.20.

4.29.5 Disconnect the exhaust line from the adjustable flow restrictor. (This is the line from the exhaust port on the sensor interface panel.)

4.29.6 Disconnect the cables from J1, J3 and J4 on the upper circuit board.

4.29.7 Disconnect the cable from J2 on the lower circuit board.

4.29.8 Disconnect the gas sample (intake) line from the brass fitting on the floor of the monitor box.

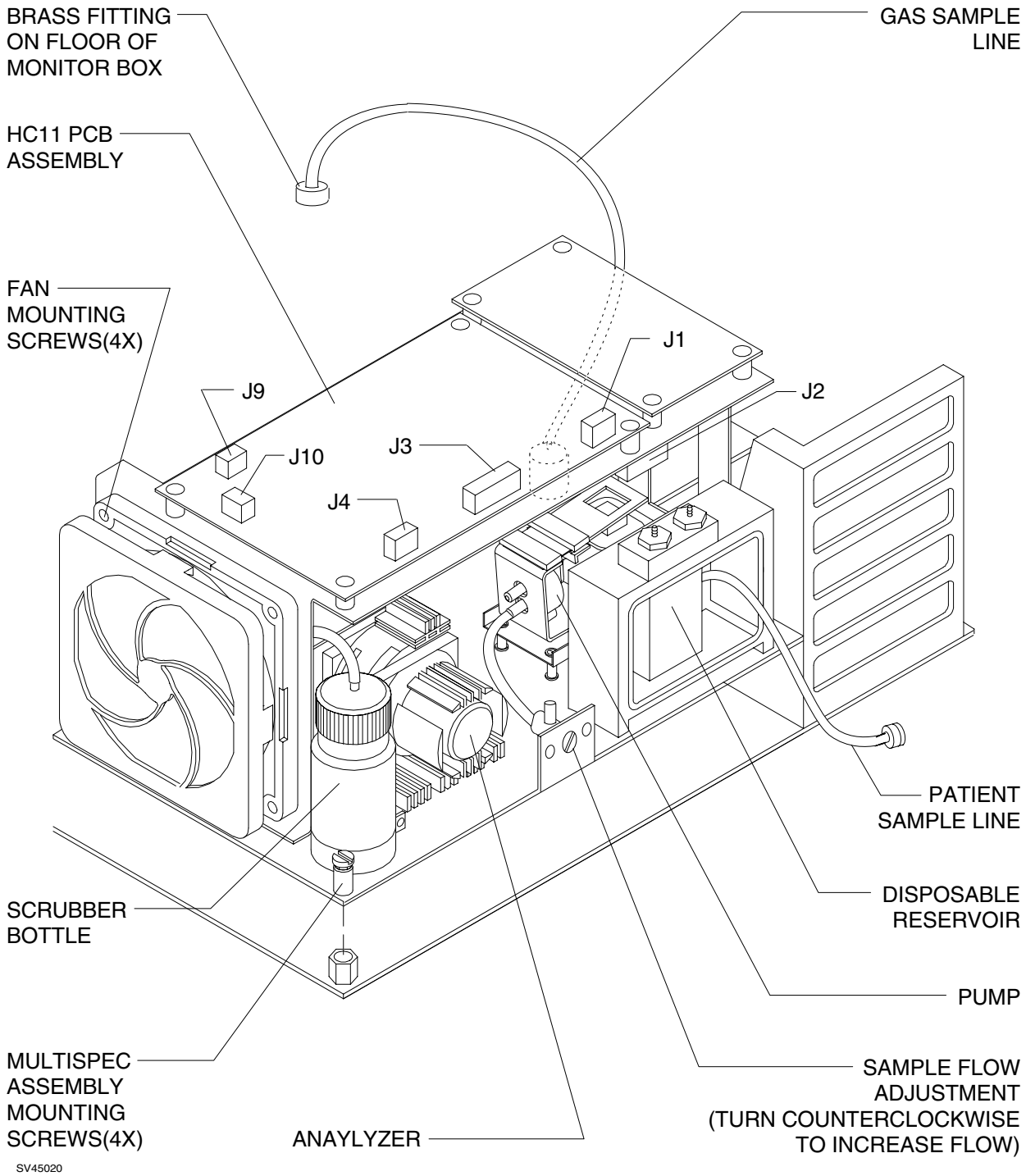



**Figure 4-29: MULTISPEC ANALYZER ASSEMBLY (MODEL 4600)**

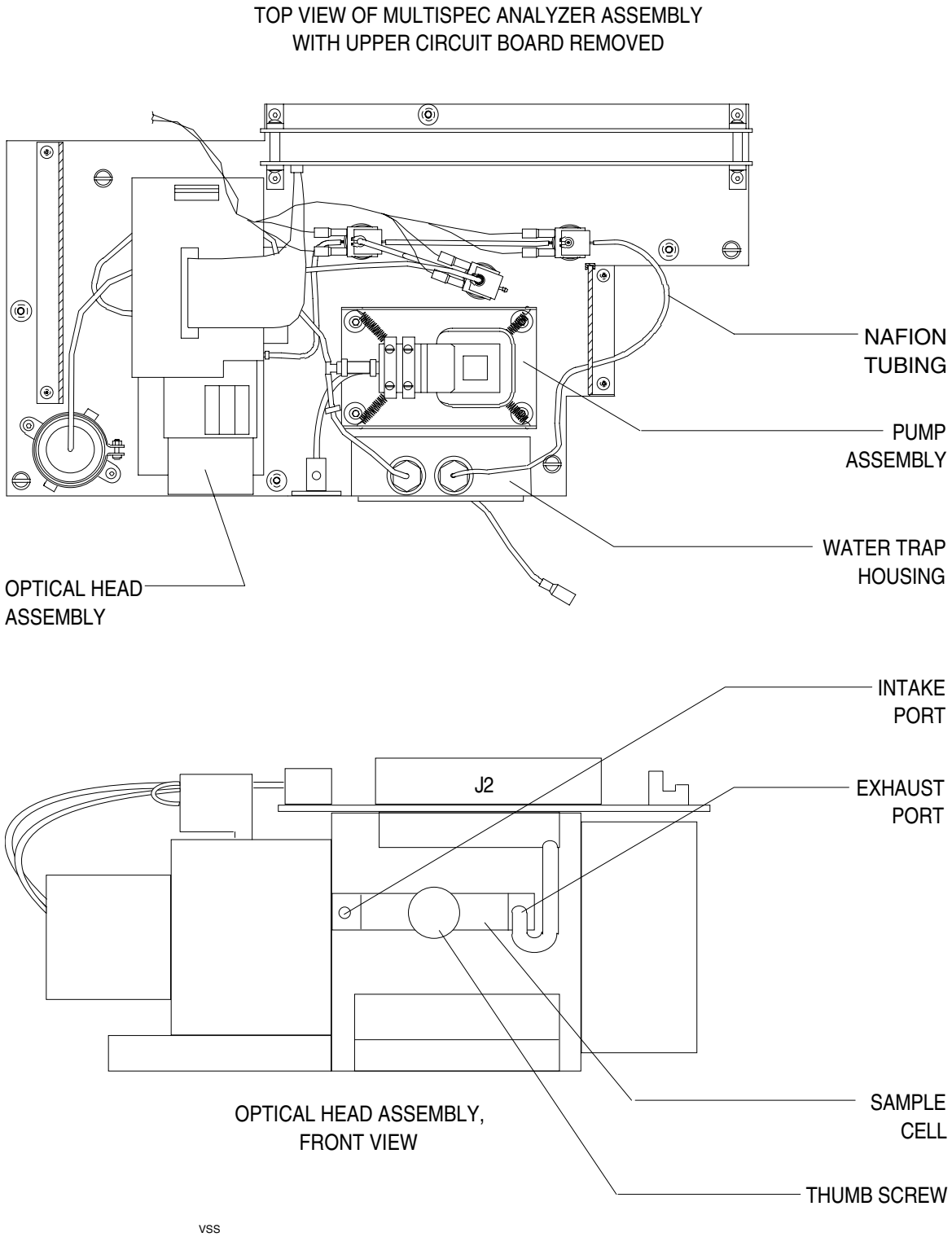



**Figure 4-29: MULTISPEC ANALYZER ASSEMBLY (MODEL 4600)(continued)**

4.29.9 Loosen the four captive mounting screws and lift the multispec analyzer assembly from the monitor box.

4.29.10 Remove the piece of gas sample line tubing from the solenoid valve in the analyzer assembly, and install it on the solenoid valve in the replacement assembly.

4.29.11 Position the replacement assembly in the monitor box and tighten the captive mounting screws.

4.29.12 Connect the gas sample line to the brass fitting on the floor of the monitor box.

4.29.13 Connect the cables that were previously removed from J1, J3 and J4 on the upper circuit board.

4.29.14 Connect the cable that was previously removed from J2 on the lower circuit board.

4.29.15 Connect the exhaust line to the flow restrictor.

4.29.16 Restore power to the machine and perform the multispec calibration procedures given in Section 5.

NOTE: If the entire analyzer assembly is replaced or if the pump is replaced, the pump flow rate must be set to the correct value as described in Section 5 under Multispec Span and Line Block Calibration.

4.29.17 Set the System Power switch on the front panel to the STANDBY position and remove AC power from the machine.

4.29.18 Replace the monitor box cover and connect the remote display cable, BP cuff and BP gauge lines and the oximeter sensor cable at the patient interface panel. Replace the disposable reservoir.

4.29.19 Perform the PMS Procedure given in Section 6.

4.29.20 Fan Replacement:

4.29.20.1 Disconnect the fan power cable from J10 on the upper circuit board.

4.29.20.2 Remove the four fan mounting screws, and remove the fan.

4.29.20.3 Install the replacement fan. Use a small amount of loctite #222 (purple) on the mounting screw threads.

4.29.20.4 Connect the fan power cable to J10 on the upper circuit board.

4.29.20.5 Proceed to Paragraph 4.29.16.

4.29.21 Scrubber Bottle Replacement:

4.29.21.1 Disconnect the inlet line at the top of the bottle.

4.29.21.2 Loosen the bottle clamp screw and remove the bottle.

4.29.21.3 Install the replacement scrubber bottle in the clamp and tighten the clamp screw.

4.29.21.4 Connect the inlet line at the top of the bottle.

4.29.21.5 Proceed to Paragraph 4.29.16.

4.29.22 Nafion Tubing Replacement:

4.29.22.1 Remove the nafion tubing from its connections on the disposable reservoir holder and the solenoid valve. See Multispec Analyzer Assembly illustration.

4.29.22.2 Install the replacement 12 in.length of nafion tubing between the disposable reservoir holder and the solenoid valve. Press the tubing ends firmly onto the hose barbs.

4.29.22.3 Proceed to Paragraph 4.29.16.

4.29.23 Sample Cell Replacement:

4.29.23.1 Remove the analyzer assembly from the monitor box as outlined in Paragraphs 4.29.5 thru 4.29.9.

4.29.23.2 Disconnect the ribbon cable from J2 on the optical head assembly circuit board.

4.29.23.3 Remove the four screws holding the optical head assembly to the analyzer chassis.

4.29.23.4 Move the optical head assembly out far enough to gain access to the sample cell, and disconnect the intake and exhaust tubing from the fittings on the sample cell.

4.29.23.5 Turn the thumbscrew of the sample cell counter-clockwise until the cell is released, and carefully withdraw the cell from the optical head assembly.

4.29.23.6 Rotate the thumbscrew on the replacement sample cell counter-clockwise several turns. Insert the samle cell into the optical head assembly, making sure that the locking tab on the screw is pointing to the right.

Turn the thumbscrew clockwise until the cell is properly seated, with the locking tab in the slot of the optical head assembly.

4.29.23.7 Connect the intake and exhaust tubing to the fittings on the sample cell.

4.29.23.8 Mount the optical head assembly to the analyzer chassis using the hardware that was previously removed. Use a small amount of loctite #222 (purple) on the screw threads.

4.29.23.9 Connect the ribbon cable that was previously removed from J2 on the optical head assembly circuit board.

4.29.23.10 Position the analyzer in the monitor box and tighten the captive mounting screws.

4.29.23.11 Proceed to Paragraph 4.29.12.

4.29.24 Pump Replacement:

4.29.24.1 Remove the analyzer assembly from the monitor box as outlined in Paragraphs 4.29.5 thru 4.29.9.

4.29.24.2 Disconnect the pump power cable from J9 on the upper circuit board.

4.29.24.3 Remove the four mounting screws for the water trap housing, and move the housing aside to gain access to the pump.

4.29.24.4 Disconnect the input and output tubing from the pump.

4.29.24.5 Remove the four nuts that hold the pump to the multispec analyzer chassis, and remove the pump.

4.29.24.6 Install the replacement pump in the rubber mounts on the analyzer chassis. Use a small amount of loctite #222 (purple) when installing the mounting nuts.

4.29.24.7. Connect the input and output tubing to the pump.

4.29.24.8 Replace the water trap housing and install its mounting screws. Use a small amount of loctite #222 (purple) on the mounting screw threads.

4.29.24.9 Connect the pump power cable to J9 on the upper circuit board.

4.29.24.10 Position the multispec analyzer in the monitor box and tighten its captive mounting screws.

4.29.24.11 Proceed to Paragraph 4.29.12.

4.29.25 HC11 PCB Assembly Replacement:

CAUTION: Use proper ESD control during the replacement procedure.

4.29.25.1 Disconnect the following cables and wire harnesses from the HC11 PCB assembly:

| | |
|---|---|
| J1 Agent Ind. | J2 Andros Pwr. Supp. |
| J3 NM4 Pwr. Supp. | J4 NM4 Serial Comm. |
| J5 Andros Drivers | J6 Andros Comm. |
| J7 (If applicable) | J8 Solenoids |
| J9 Pump | J10 Fan |

4.29.25.2 Remove the four mounting screws at the corners of the PCB assembly, and remove the assembly from the analyzer.

4.29.25.3 Position the replacement PCB assembly on the analyzer chassis, and secure it with the four mounting screws that were previously removed.

4.29.25.4 Reconnect all of the cables and wire harnesses that were previously disconnected, J1 thru J10.

4.29.25.5 Proceed to Paragraph 4.29.16.

4.29.26 Firmware Replacement:

CAUTION: Use proper ESD control during the replacement procedure.

4.29.26.1 Locate firmware chip U4 on the HC11 PCB assembly (see illustration on next page) and carefully remove the chip using a 52-pin extraction tool (P/N S0010069).

4.29.26.2 Carefully insert the replacement firmware chip into the socket, ensuring that its index is oriented as shown in the illustration. Verify that the label on the chip corresponds to the desired firmware version number.

4.29.26.3 Proceed to Paragraph 4.29.16.

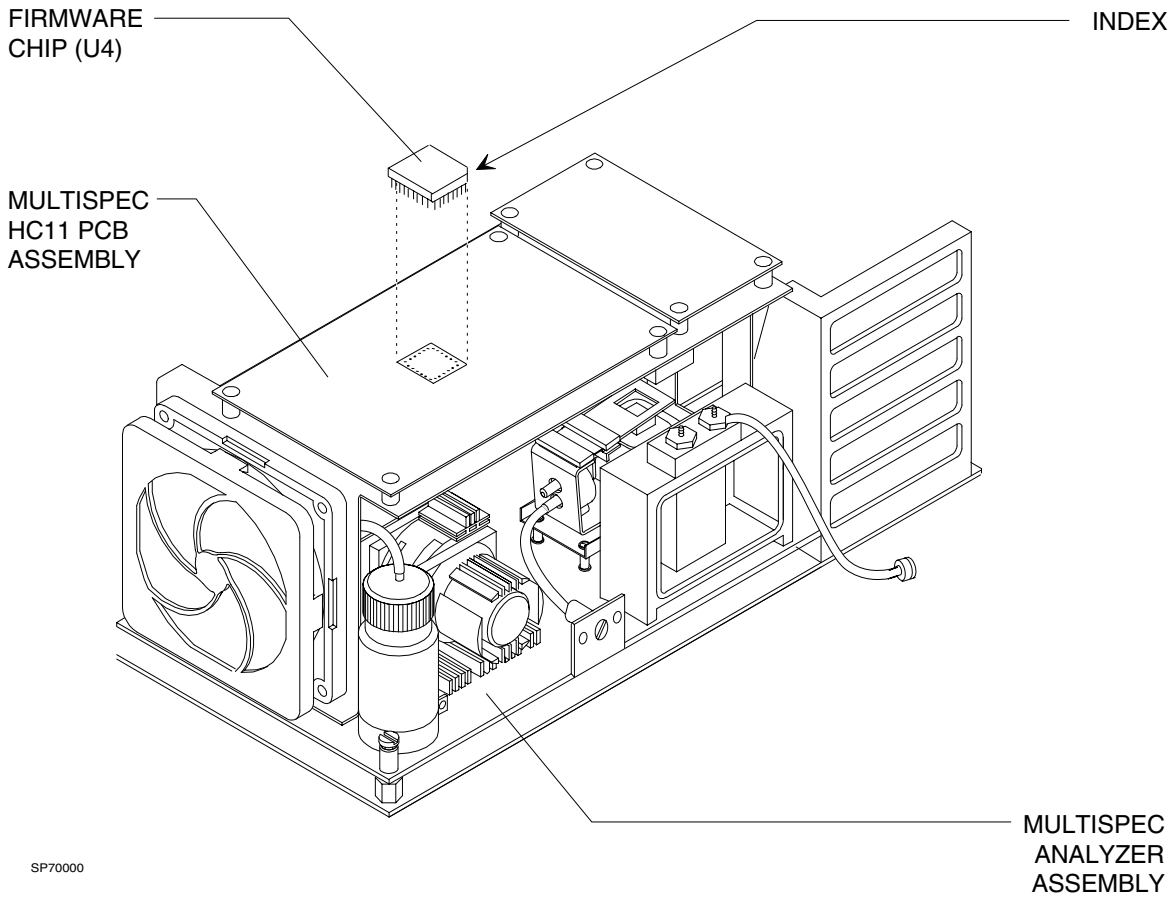



**Figure 4-29A: MULTISPEC HC11 FIRMWARE LOCATION (MODEL 4600)**

## 4.30 Multispec Analyzer Assembly (Model 4610)

The multispec analyzer assembly is located in the left rear corner of the monitor box. Access to the assembly requires removal of the monitor box cover. The analyzer assembly contains several field-replaceable sub-assemblies. These are: the fan, the adjustable exhaust restrictor, the sample cell, the PVC sample line, the air filter, the pump, the HC11 PCB assembly and the firmware EPROM. Replacement of the sample cell or the pump requires that the multispec analyzer assembly be removed from the monitor box. Figure 4-30 shows the general arrangement of the multispec analyzer assembly and its connections.

NOTE: If the Model 4610 Multispec Analyzer Assembly is replacing a Model 4600, refer to Service Procedure 00117 for installation instructions.

4.30.1 Set the System Power switch on the front panel to the STANDBY position and remove AC power from the machine.

CAUTION: Do not plug or unplug remote display with power applied.

4.30.2 Disconnect the following items from the patient interface panel on the left side of the monitor box:

-Remote Display and Datagrip cables

-BP Cuff and BP Gauge lines

-Pulse Oximeter Sensor cable

4.30.3 Remove the disposable reservoir from its holder.

4.30.4 Remove the six screws holding the monitor box cover, and carefully lift the cover from the monitor box.

NOTE: The following procedure applies to replacement of the entire analyzer assembly. Procedures for replacement of sub-assemblies begin at Paragraph 4.30.18.

4.30.5 Disconnect the exhaust line from the adjustable restrictor.

4.30.6 Disconnect the cables from J1, J3 and J4 on the HC11 PCB assembly. See Figure 4-30A.

4.30.7 Disconnect the gas sample (intake) line from the brass fitting on the floor of the monitor box.

4.30.8 Loosen the four captive mounting screws and lift the multispec analyzer assembly from the monitor box.

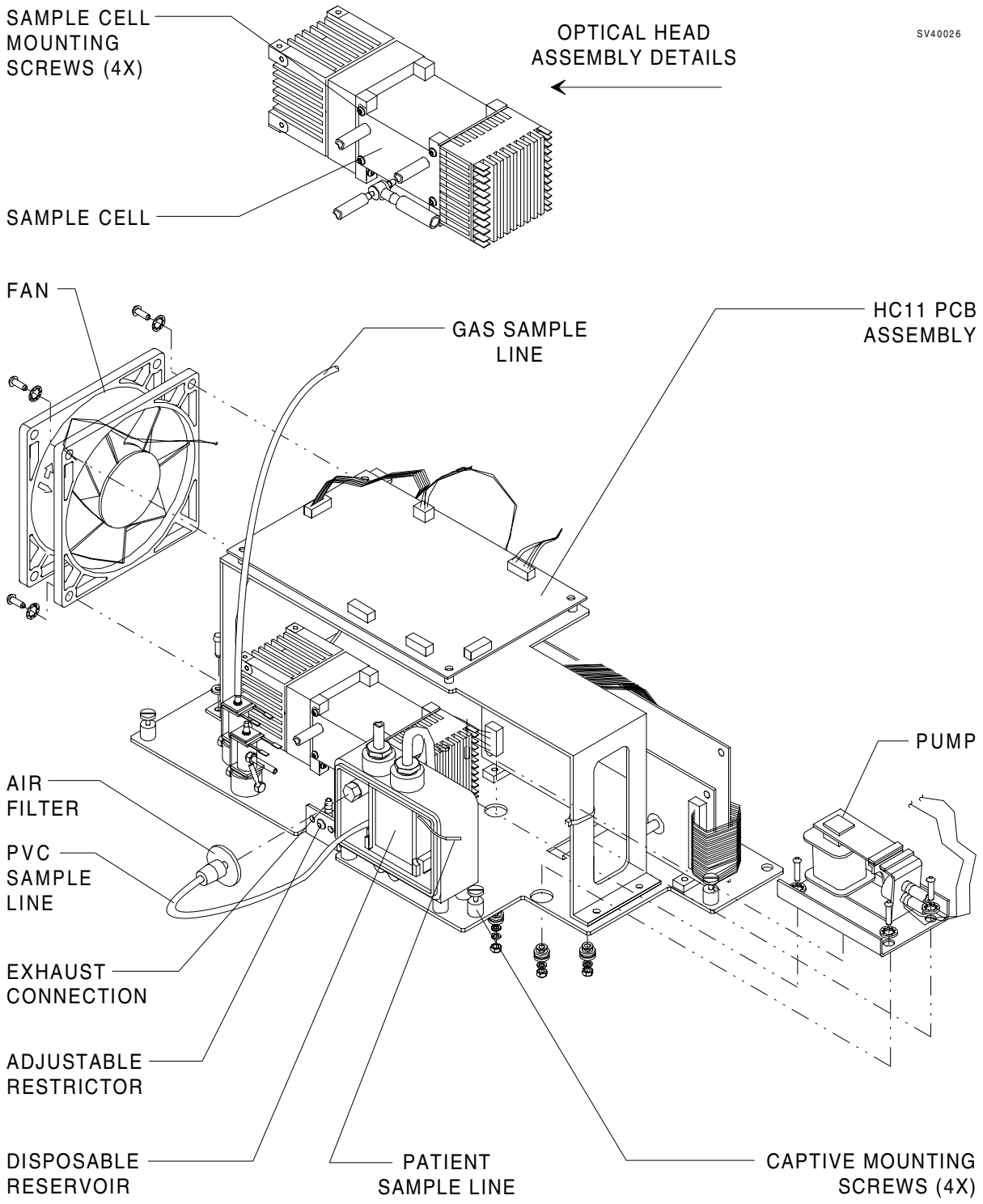



**Figure 4-30: MULTISPEC ANALYZER ASSEMBLY (MODEL 4610)**

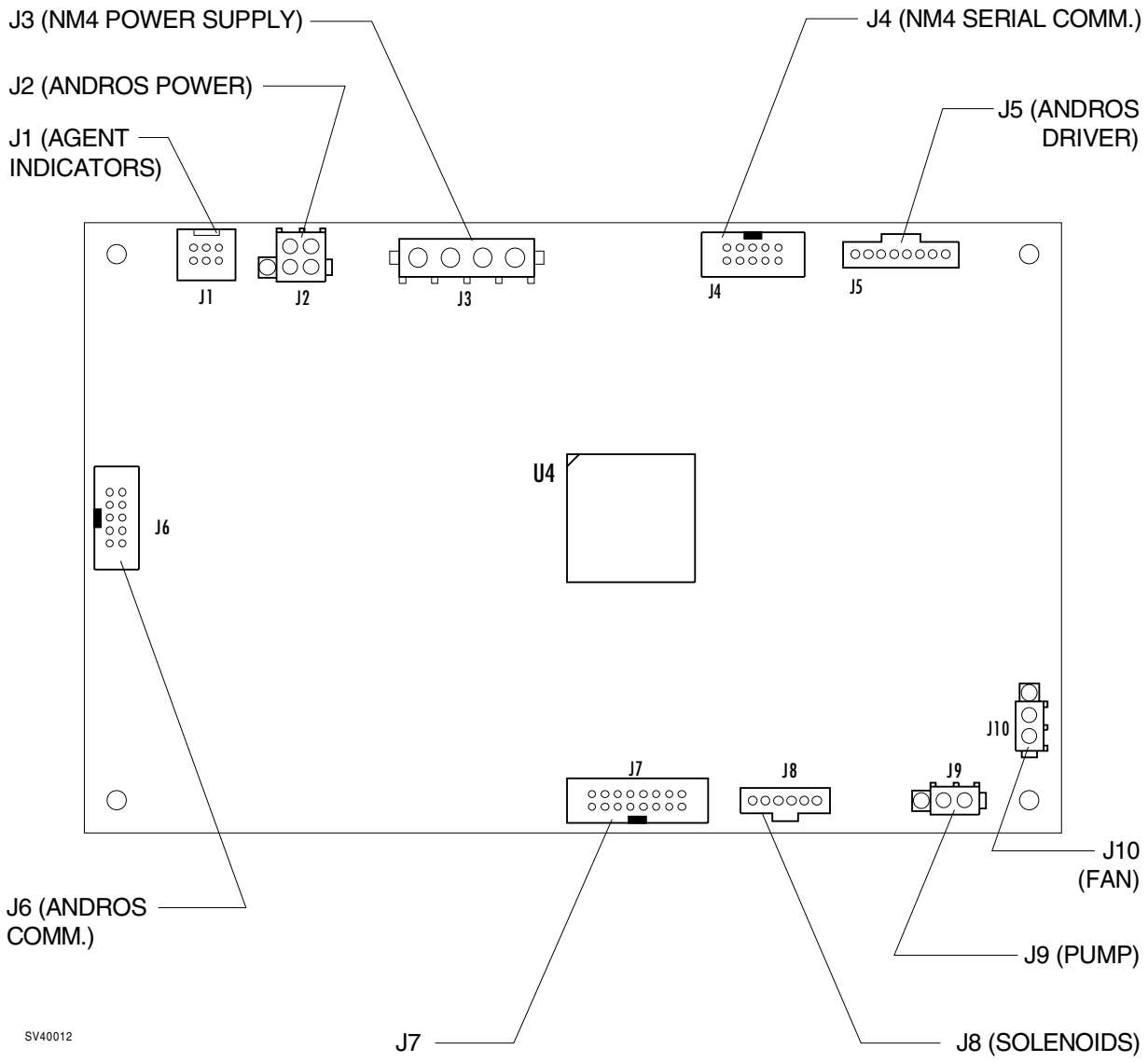



**Figure 4-30A: MULTISPEC HC11 PCB ASSEMBLY CONNECTIONS (MODEL 4610)**

4.30.9 Remove the piece of gas sample line tubing from the solenoid valve in the analyzer assembly, and install it on the solenoid valve in the replacement assembly.

4.30.10 Position the replacement assembly in the monitor box and tighten the captive mounting screws.

4.30.11 Connect the gas sample line to the brass fitting on the floor of the monitor box.

4.30.12 Connect the cables that were previously removed from J1, J3 and J4 on the HC11 PCB assembly.

4.30.13 Connect the exhaust line to the adjustable restrictor.

4.30.14 Restore power to the machine and perform the multispec calibration procedures given in Section 5.

NOTE: If the entire analyzer assembly is replaced or if the pump is replaced, the pump flow rate must be set to the correct value as described in Section 5 under Multispec Span and Line Block Calibration.

4.30.15 Set the System Power switch on the front panel to the STANDBY position and remove AC power from the machine.

4.30.16 Replace the monitor box cover and connect the remote display cable, BP cuff and BP gauge lines and the oximeter sensor cable at the patient interface panel. Replace the disposable reservoir.

4.30.17 Perform the PMS Procedure given in Section 6.

---

4.30.18 Fan Replacement:

4.30.18.1 Disconnect the fan wire harness from J10 on the HC11 PCB assembly.

4.30.18.2 Remove the four fan mounting screws, and remove the fan.

4.30.18.3 Install the replacement fan. Use a small amount of Loctite #222 (purple) on the mounting screw threads.

4.30.18.4 Connect the fan wire harness to J10 on the HC 11 PCB assembly.

4.30.18.5 Proceed to Paragraph 4.30.14.

4.30.19 PVC Sample Line Replacement:

4.30.19.1 At the water trap housing, disconnect the sample line Luer fitting from the air filter.

4.30.19.2 Disconnect the other end of the sample line from the hose barb on the solenoid, and carefully withdraw the sample line through the bushing in the water trap housing.

4.30.19.3 Insert the end of the replacement sample line through the bushing in the water trap housing, and connect it to the hose barb on the solenoid where the original sample line was removed.

4.30.19.4 Connect the Luer fitting on the outboard end of the sample line to the air filter.

4.30.19.5 Proceed to Paragraph 4.30.14.

4.30.20 Air Filter Replacement:

4.30.20.1 At the water trap housing, disconnect the sample line Luer fitting from the air filter.

4.30.20.2 Remove the air filter from the Luer fitting in the water trap housing.

NOTE: On later model gas analyzers the Luer fitting in the water trap housing and the Luer fitting on the PVC sample line have a different gender arrangement than previous models. The later arrangement prevents connection of the PVC sample line to the water trap housing without an air filter. (The same air filter is used-oriented 180° from the previous arrangement.)

4.30.20.3 Attach the replacement air filter to the Luer fitting in the water trap housing.

4.30.20.4 Connect the PVC sample line to the to the air filter.

4.30.20.5 Proceed to Paragraph 4.30.14.

4.30.21 Sample Cell Replacement:

NOTE: The next four steps apply to analyzer assemblies where the optical head assembly must be removed from the chassis in order to gain access to the sample cell. Skip these steps if the the analyzer arrangement allows access to the sample cell mounting screws without further disassembly.

4.30.21.1 Remove the analyzer assembly from the monitor box as outlined in Paragraphs 4.30.5 thru 4.30.8.

4.30.21.2 Disconnect the ribbon cable from the optical head assembly circuit board.

4.30.21.3 Disconnect the intake and exhaust tubing from the fittings on the sample cell.

4.30.21.4 Remove the four screws holding the optical head assembly to the analyzer chassis, and carefully lift out the optical head assembly. Note the arrangement of the mounting hardware so that the assembly can be reinstalled in the same manner.

4.30.21.5 Remove the four screws holding the sample cell to the optical head assembly and withdraw the sample cell.

4.30.21.6 Position the replacement sample cell in the optical head assembly and secure it with the four screws that were previously removed.

4.30.21.7 Reinstall the optical head assembly on the analyzer chassis using the mounting hardware that was previously removed. Use a small amount of Loctite #222 (purple) on the screw threads.

4.30.21.8 Connect the intake and exhaust tubing to the fittings on the sample cell.

4.30.21.9 Connect the ribbon cable that was previously removed from the optical head assembly circuit board.

4.30.21.10 Position the multispec analyzer assembly in the monitor box and tighten the captive mounting screws.

4.30.21.11 Proceed to Paragraph 4.30.11.

4.30.22 Adjustable Restrictor Replacement:

4.30.22.1 Disconnect the exhaust line from the hose barb on the restrictor (if not previously disconnected).

4.30.22.2 Remove the two screws securing the restrictor to the chassis.

4.30.22.3 Disconnect the pump exhaust tubing from the restrictor, and remove the restrictor.

4.30.22.4 Connect the pump exhaust tubing to the replacement restrictor, and secure the restrictor to the chassis with the screws that were previously removed.

4.30.22.5 Connect the exhaust line to the restrictor and proceed to Paragraph 4.30.14.

4.30.23 Pump Replacement:

4.30.23.1 Remove the analyzer assembly from the monitor box as outlined in Paragraphs 4.30.5 thru 4.30.8.

4.30.23.2 Disconnect the pump wire harness from J9 on the HC11 PCB assembly.

4.30.23.3 Disconnect the input and output tubing from the pump.

4.30.23.4 Remove the four nuts that hold the pump to the multispec analyzer chassis, and remove the pump.

4.30.23.5 Install the replacement pump in the rubber mounts on the analyzer chassis. Use a small amount of loctite #222 (purple) when installing the mounting nuts.

4.30.23.6. Connect the input and output tubing to the replacement pump.

4.30.23.7 Connect the pump wire harness to J9 on the HC11 PCB assembly.

4.30.23.8 Position the multispec analyzer in the monitor box and tighten its captive mounting screws.

4.30.23.9 Proceed to Paragraph 4.30.11.

4.30.24 HC11 PCB Assembly Replacement:

CAUTION: Use proper ESD control during the replacement procedure.

4.30.24.1 Disconnect the following cables and wire harnesses from the HC11 PCB assembly (ref. Figure 4-30A):

| | |
|---|---|
| J1 Agent Ind. | J2 Andros Pwr. Supp. |
| J3 NM4 Pwr. Supp. | J4 NM4 Serial Comm. |
| J5 Andros Drivers | J6 Andros Comm. |
| J7 (If applicable) | J8 Solenoids |
| J9 Pump | J10 Fan |

4.30.24.2 Remove the four mounting screws at the corners of the PCB assembly, and remove the assembly from the analyzer.

4.30.24.3 Position the replacement PCB assembly on the analyzer chassis, and secure it with the four mounting screws that were previously removed.

4.30.24.4 Reconnect all of the cables and wire harnesses that were previously disconnected, J1 thru J10.

4.30.24.5 Proceed to Paragraph 4.30.14.

4.30.25 Firmware Replacement:

CAUTION: Use proper ESD control during the replacement procedure.

4.30.25.1 Locate firmware chip U4 on the HC11 PCB assembly (see Figure 4-30B) and carefully remove the chip using a 52-pin extraction tool (P/N S0010069).

4.30.25.2 Carefully insert the replacement firmware chip into the socket, ensuring that its index is oriented as shown in the illustration. Verify that the label on the chip corresponds to the desired firmware version number.

4.30.25.3 Reinstall the HC11 PCB assembly as outlined in Paragraph 4.30.22.

4.30.25.4 Proceed to Paragraph 4.30.14.

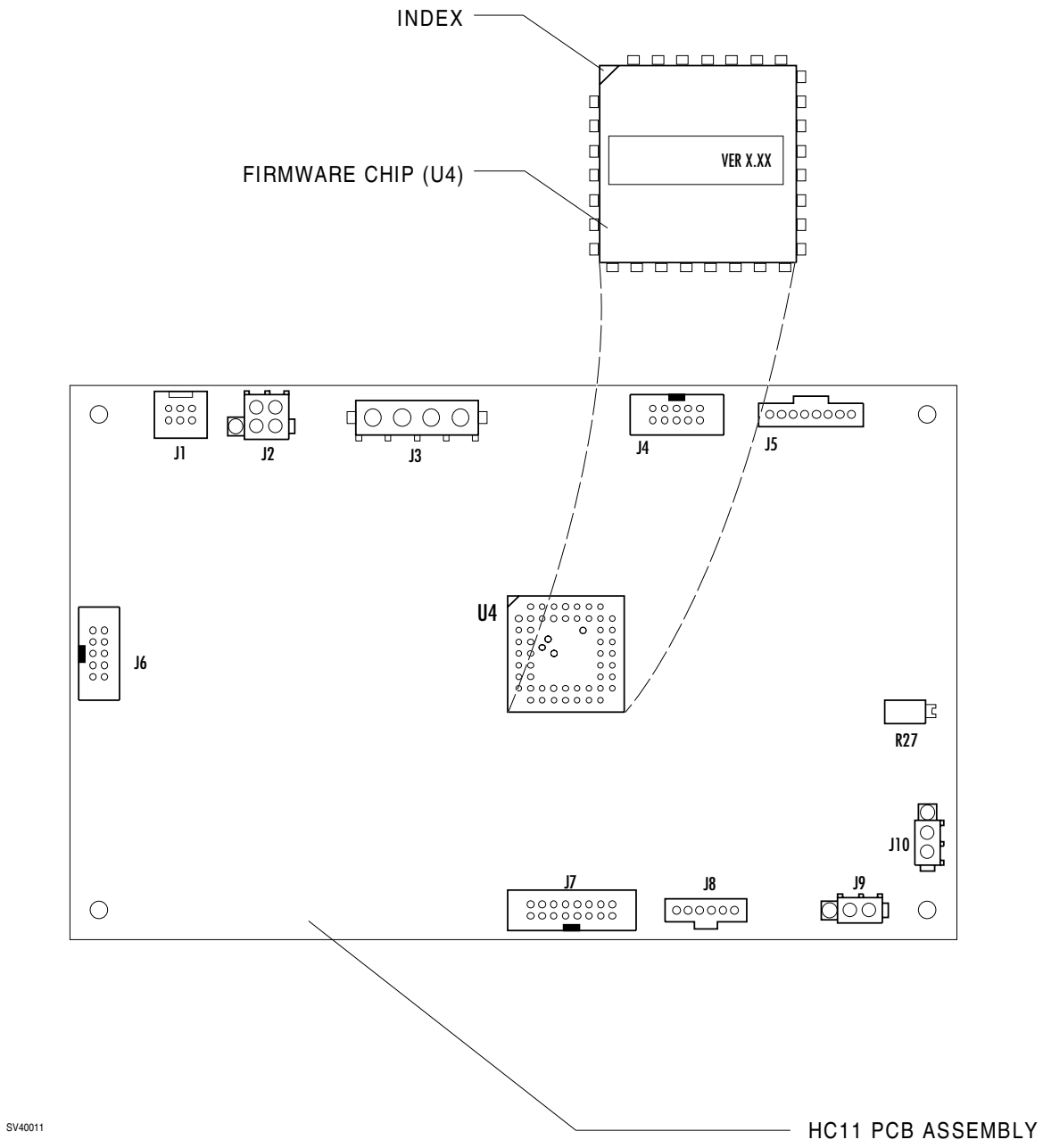



**Figure 4-30B: MULTISPEC HC11 FIRMWARE LOCATION (MODEL 4610)**

## 4.31 Front Bezel Assembly

The front bezel assembly includes the left and right display panels, key panels, selection dial encoder and touch screen circuitry. Replacement of the bezel assembly requires removal of the monitor box cover. Refer to Figure 4-31 for the general arrangement of the assembly and its cables, and the mounting screw locations.

4.31.1 Set the System Power switch on the front panel to the STANDBY position and remove AC power from the machine.

CAUTION: Do not plug or unplug remote display with power applied.

4.31.2 Disconnect the following items from the patient interface panel on the left side of the monitor box:

-Remote Display and Datagrip cables
-BP Cuff and BP Gauge lines
-Pulse Oximeter Sensor cable

4.31.3 Remove the disposable reservoir from its holder.

4.31.4 Remove the six screws holding the monitor box cover, and carefully lift the cover from the monitor box.

4.31.5 Disconnect the following cables from the backplane circuit board:

-Left display panel cable from J7
-Right display panel cable from J6
-Touch panel cables from J4 and J5
-Selection dial cable from J26

4.31.6 Disconnect the ground wire from the monitor box chassis.

4.31.7 While holding the bezel assembly, loosen the four captive mounting screws and slide the bezel assembly to the left. Lift the assembly from the monitor box.

4.31.8 Position the replacement bezel assembly over the mounting holes in the monitor box and fasten the captive mounting screws.

NOTE: Ensure that the replacement bezel assembly is electrically compatible with the existing processor boards. Refer to the part number combinations listed in Section 8.

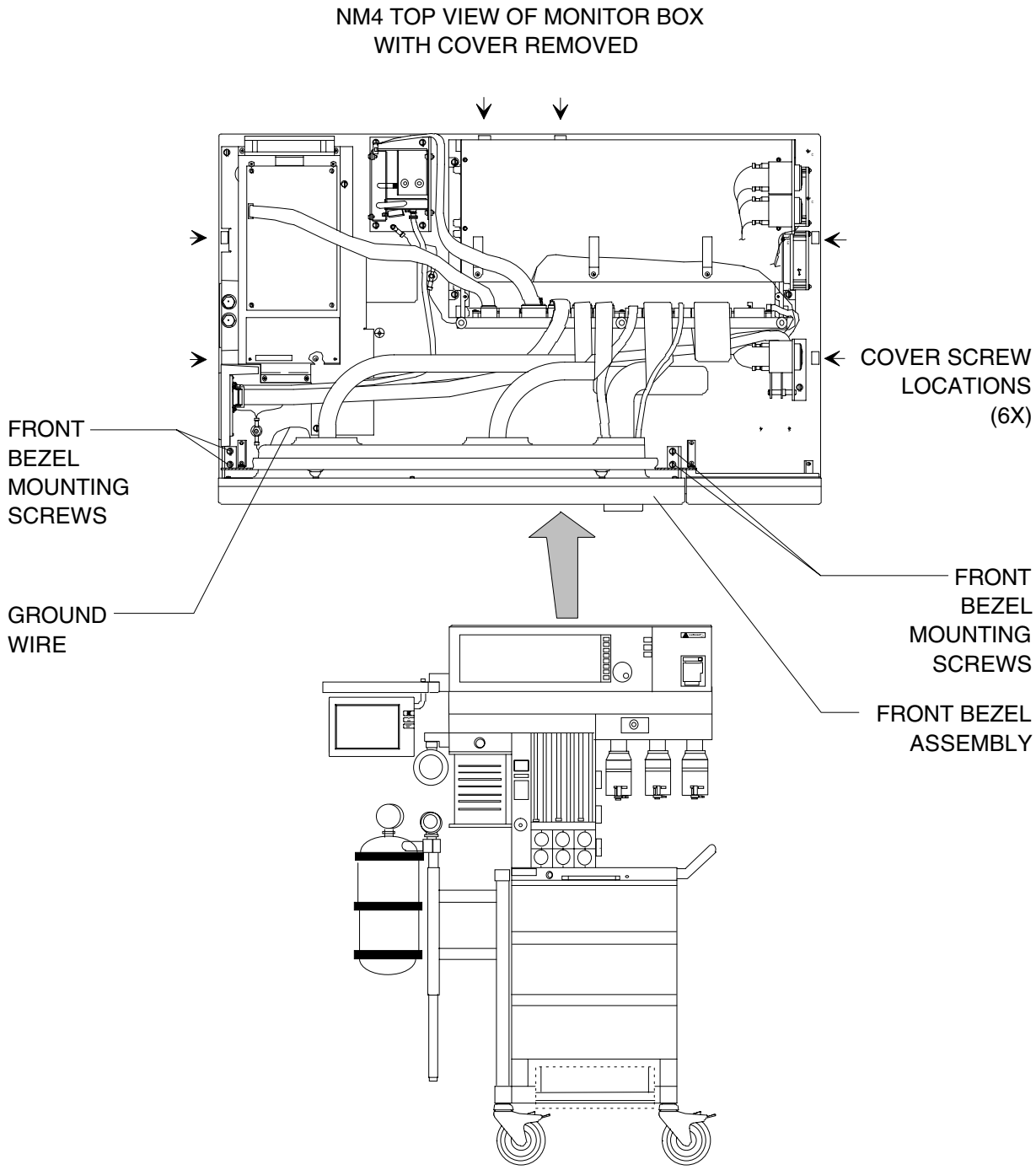



**Figure 4-31: FRONT BEZEL ASSEMBLY**

4.31.9 Connect the ground wire to the monitor box chasis

4.31.10 Join the cables from the replacement bezel assembly to their correct connectors on the backplane circuit board.

4.31.11 Restore power to the machine and run the keys and touch screen diagnostics tests given in Section 2 to verify that the replacement bezel assembly is working properly.

4.31.12 Set the System Power switch on the front panel to STANDBY.

4.31.13 Replace the monitor box cover and reconnect the items that were previously disconnected from the patient interface panel.

4.31.14 Replace the disposable reservoir.

4.31.15 Perform the PMS Procedure given in Section 6.

## 4.32 Remote Display Assembly (without Datagrip)

The remote display is located at the outboard end of the boom arm and comprises the display panel and its associated circuitry, the keypad switches and the cable assembly that provides for communications with the machine. Figure 4-32 illustrates the remote display mounting arrangement.

4.32.1 Set the System Power switch on the front panel to the STANDBY position and remove AC power from the machine.

CAUTION: Do not plug or unplug remote display with power applied.

4.32.2 Disconnect the remote display cable from the left side panel of the monitor box and separate the cable from the retainer clamps along the boom arm.

4.32.3 Remove the plastic cap at the end of the boom arm to expose the remote display assembly mounting screw.

4.32.4 While holding the remote display, loosen its mounting screw until the display assembly separates from the boom arm.

4.32.5 Mount the replacement display assembly to the boom arm and tighten its mounting screw to a torque of 3 to 5 foot pounds. Replace the plastic cap covering the mounting screw recess.

4.32.6 Install the remote display cable in its retainer clamps along the boom arm and connect the cable to the panel on the left side of the monitor box.

4.32.7 Restore power to the machine and verify the operation of the remote display by running the service diagnostics described in Section 2.

4.32.8 Perform the PMS Procedure given in Section 6.

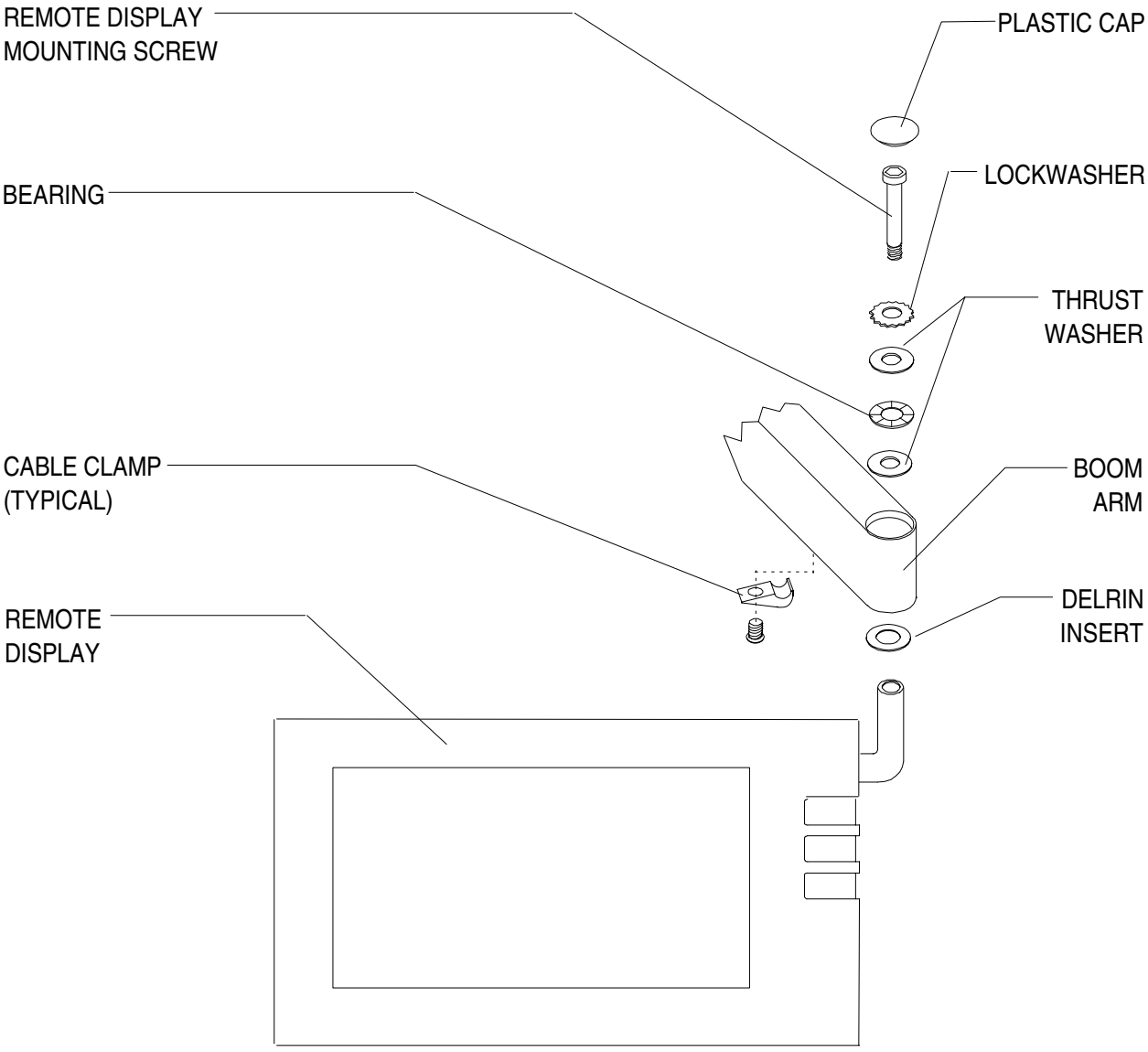



**Figure 4-32: REMOTE DISPLAY ASSEMBLY**

## 4.33 Remote Display Assembly (with Datagrip)

The Remote Display Assembly is mounted on a rod extending from the Datagrip assembly located at the outboard end of the display arm. Figure 4-33 illustrates the Display assembly mounting arrangement. A later style display arm is illustrated; the display mounting principle is the same on the earlier style boom arm.

4.33.1 Turn the System Power switch to STANDBY and remove AC power from the machine.

CAUTION: Do not plug or unplug remote display or Datagrip with power applied.

4.33.2 Disconnect the remote display cable from its port on the underside of the ventilator box.

4.33.3 Remove the screws holding the cable clamps along the display arm and separate the cables from the display arm.

4.33.4 Loosen the display mounting clamp screws (accessible through clearance holes in the back cover of the display).

4.33.5 Orient the display with its face toward the floor, or as needed to enable the mounting clamps to slide past the stop pins on the mounting rod, and pull the display from the rod.

4.33.6 Slide the replacement display assembly onto the mounting rod, oriented so that the mounting clamps in the display assembly slide past the stop pins on the rod - until the display is in the correct position on the rod.

4.33.7 Tighten the display mounting clamp screws (accessible through clearance holes in the back cover of the display) until the display has the desired amount of friction on the mounting rod.

4.33.8 Install the remote display and Datagrip cables in the cable clamps that were previously removed, and reinstall their screws along the display arm. Ensure that the display arm has full range of motion with no binding caused by the cables.

4.33.9 Connect the remote display and Datagrip cables to their ports on the left side of the monitor box.

4.33.10 Restore power to the machine and verify operation of the remote display and Datagrip by exercising the display selections.

4.33.11 Perform the PMS Procedure given in Section 6.

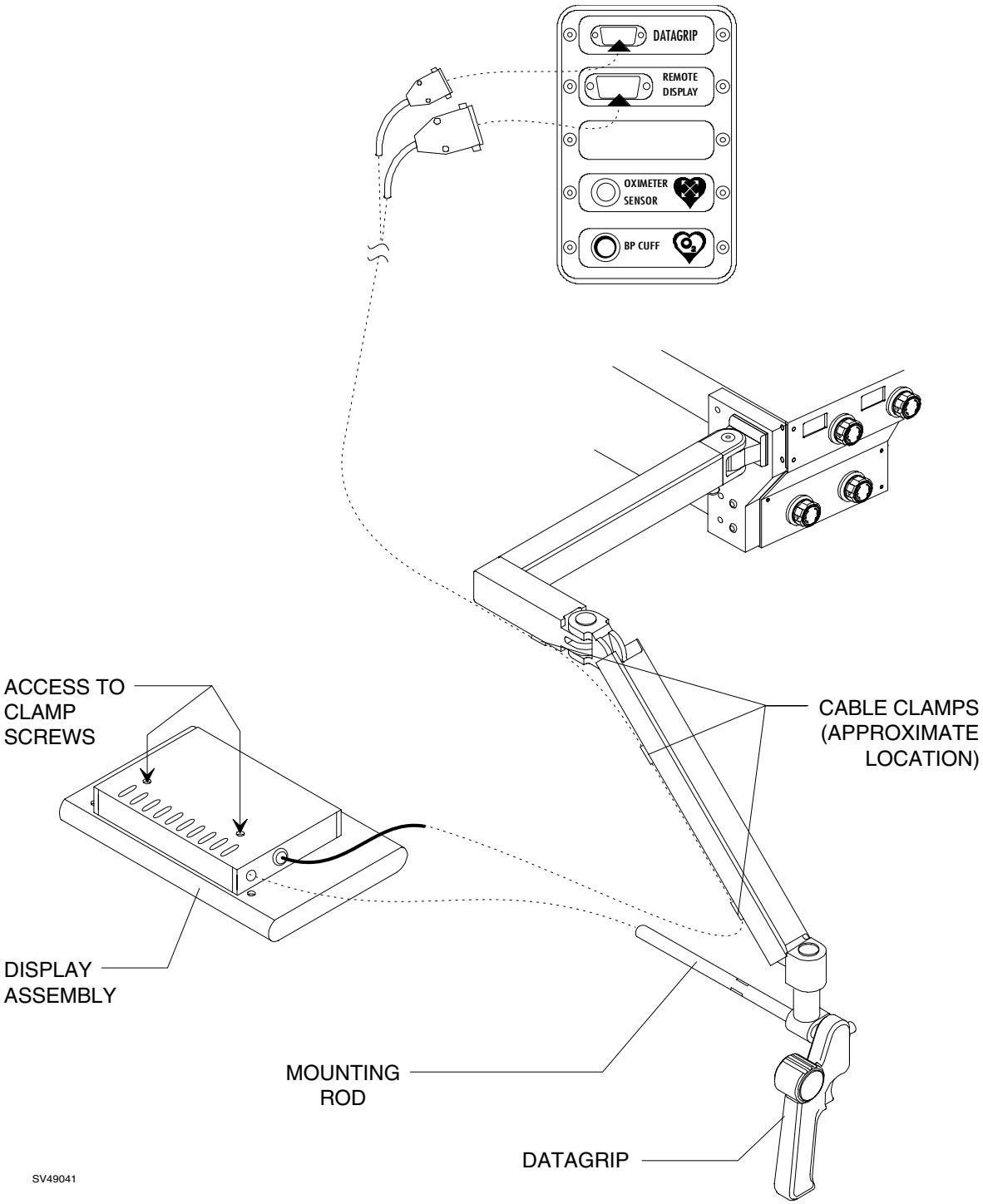



**Figure 4-33: REMOTE DISPLAY ASSEMBLY**

## 4.34 Datagrip Assembly

The Datagrip Assembly is attached to the outboard end of the display arm and comprises the handle and trigger switch, thumbwheel encoder, cable, and mounting rod for the display. The remote display must be removed from the Datagrip assembly before the assembly is removed from the display arm. (Refer to the illustration (Figure 4-33) accompanying the remote display replacement procedure for details on remote display removal.) Figure 4-34 shows the Datagrip assembly mounting arrangement. A later style display arm is illustrated; the Datagrip mounting principle is the same on the earlier style boom arm.

4.34.1 Turn the System Power switch to STANDBY and remove AC power from the machine.

CAUTION: Do not plug or unplug remote display or Datagrip with power applied.

4.34.2 Disconnect the Datagrip and remote display cables from their ports on the underside of the ventilator box.

4.34.3 Remove the screws holding the cable clamps along the display arm and separate the cables from the display arm.

4.34.4 Loosen the display mounting clamp screws (accessible through clearance holes in the back cover of the display).

4.34.5 Orient the display with its face is toward the floor, or as needed to enable the mounting clamps to slide past the stop pins on the mounting rod, and pull the display from the rod.

4.34.6 Remove the plastic cap at the end of the display arm to expose the Datagrip assembly mounting screw.

4.34.7 While holding the Datagrip assembly, loosen the mounting screw until the assembly separates from the display arm.

4.34.8 Mount the replacement Datagrip assembly to the display arm and tighten its mounting screw to a torque of 3 to 5 foot pounds. Reinstall the plastic cap to cover the mounting screw recess.

4.34.9 Slide the display onto the mounting rod, oriented so that the mounting clamps in the display assembly slide past the stop pins on the rod - until the display is in the correct position on the rod.

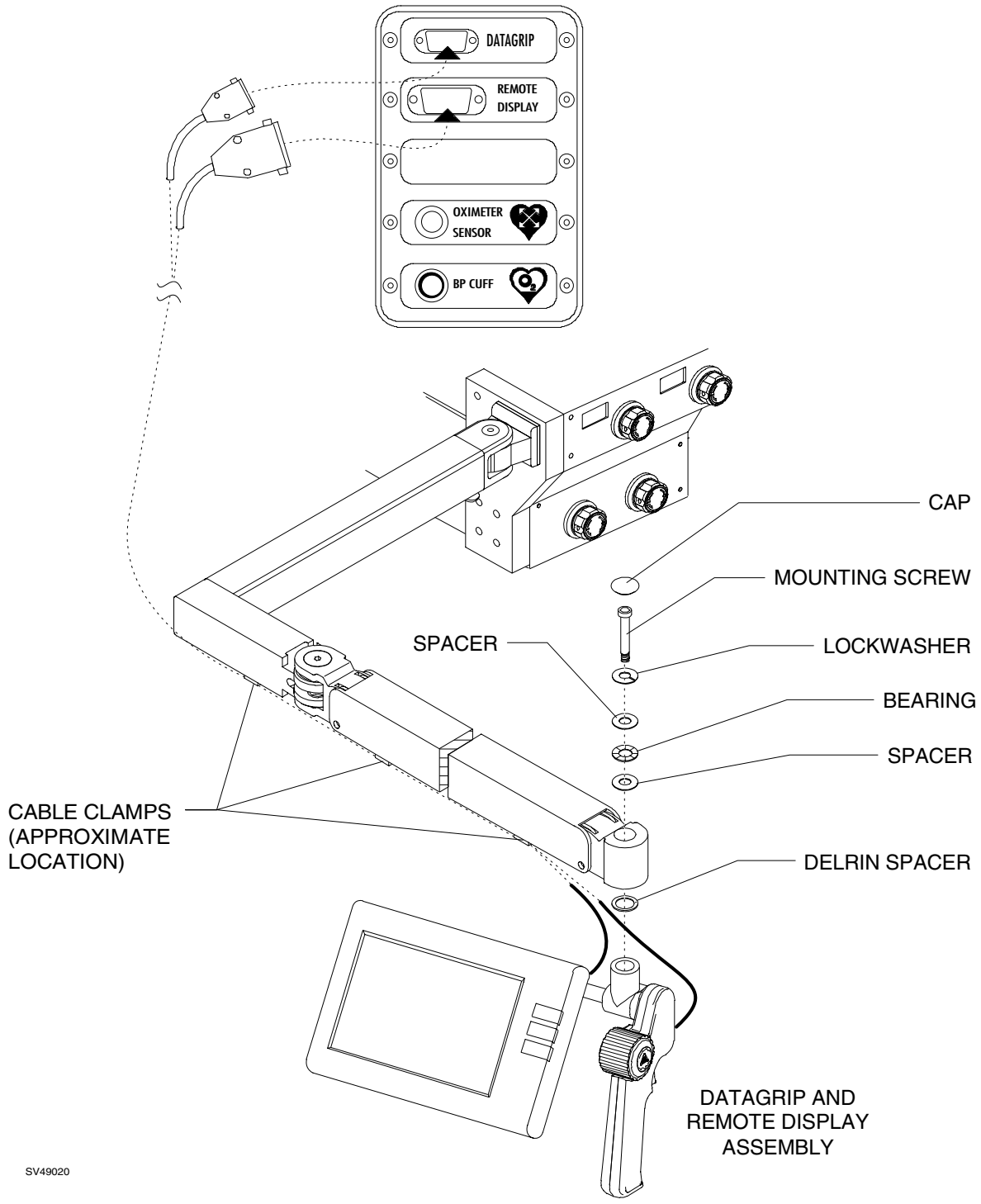



**Figure 4-34: DATAGRIP ASSEMBLY**

4.34.10 Tighten the display mounting clamp screws (accessible through clearance holes in the back cover of the display) until the display has the desired amount of friction on the mounting rod.

4.34.11 Install the remote display and Datagrip cables in the cable clamps that were previously removed, and reinstall their screws along the display arm. Ensure that the display arm has full range of motion with no binding caused by the cables.

4.34.12 Connect the remote display and Datagrip cables to their ports on the left side of the monitor box.

4.34.13 Restore power to the machine and verify operation of the remote display and Datagrip by exercising the display selections.

4.34.14 Perform the PMS Procedure given in Section 6.

## 4.35 NIBP Pump and Sensor Circuit Assembly

The location of the NIBP pump and sensor circuit assembly within the monitor box is shown in Figure 4-35 along with a detail of the mounting screws and connections to the assembly. The monitor box cover must be removed to gain access to this assembly.

Figure 4-35A shows the arrangement of the pump assembly on later model or retrofitted machines where the pump and power module bracket assembly is mounted on an adapter plate that is permanently attached to the monitor box.

4.35.1 Set the System Power switch on the front panel to the STANDBY position and remove AC power from the machine.

CAUTION: Do not plug or unplug remote display with power applied.

4.35.2 Disconnect the following items from the patient interface panel on the left side of the monitor box:

-Remote Display and Datagrip cables
-BP Cuff and BP Gauge lines
-Pulse Oximeter Sensor cable

4.35.3 Remove the disposable reservoir from its holder.

4.35.4 Remove the six screws holding the monitor box cover, and carefully lift the cover from the monitor box.

NOTE: The cable connector on the circuit board is not keyed. Note the position of the connector so that it can be connected to the replacement unit in the same manner.

4.35.5 Disconnect the ribbon cable from the assembly.

4.35.6 Cut the tie-wrap clamp on the BP cuff tubing and remove the tubing from the assembly.

4.35.7 Disconnect the ground wire from the monitor box chassis.

4.35.8 Loosen the four captive mounting screws holding the assembly to the monitor box, and remove the assembly (early models).

On later models, loosen the two captive mounting screws at the rear of the assembly; slide the assembly toward the rear and lift it from the adapter plate.

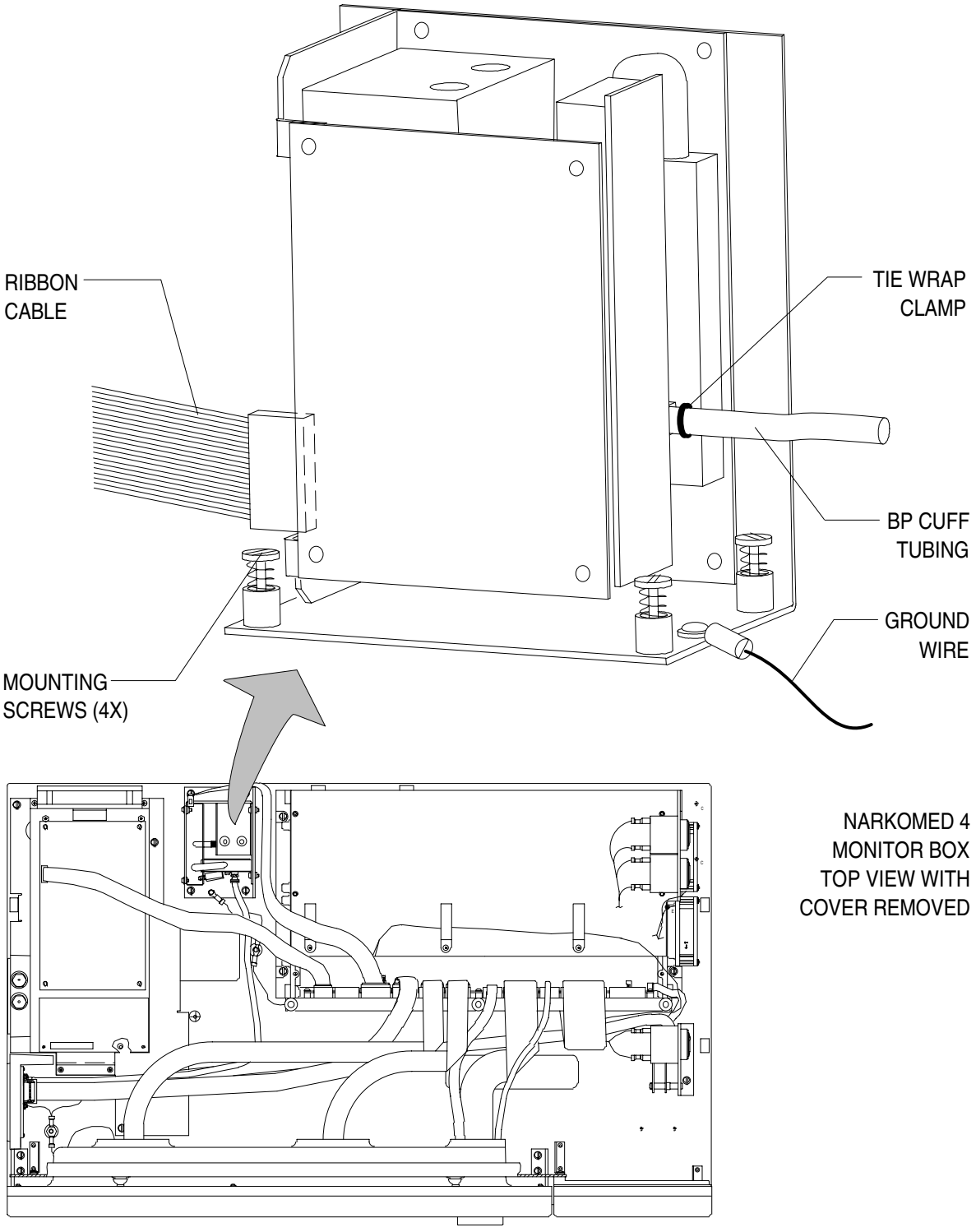
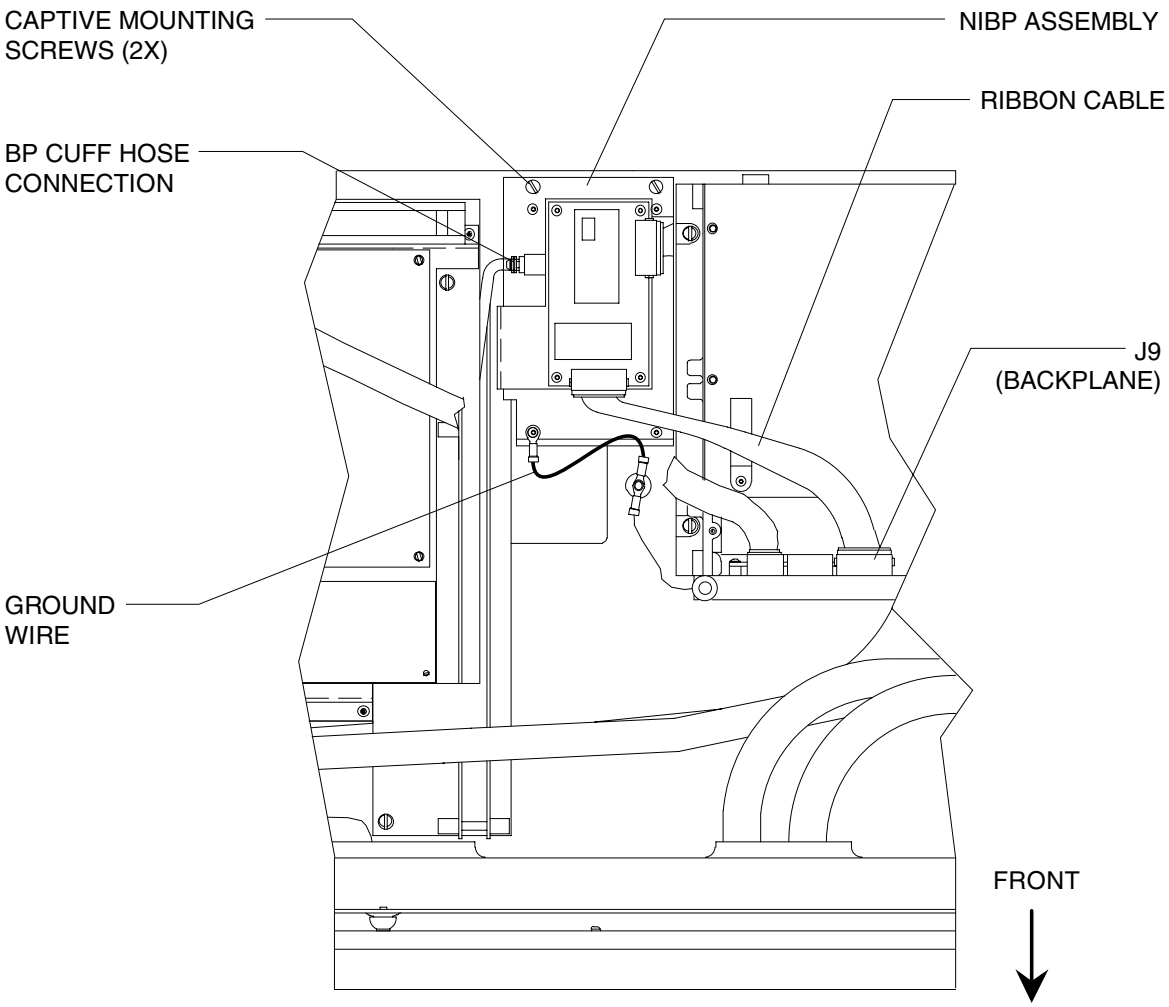



**Figure 4-35: NIBP PUMP ASSEMBLY (EARLY MODELS)**




TOP VIEW OF NARKOMED 4
MONITOR CHASSIS WITH COVER REMOVED

**Figure 35A: NIBP PUMP AND POWER MODULE ASSEMBLY (LATER MODELS)**

4.35.9 Position the replacement assembly over the mounting holes in the monitor box and fasten the captive mounting screws; connect the ground wire to the monitor box chassis.

On later models, install the replacement assembly onto the adapter plate by placing the slotted holes over the shouldered screws in the adapter plate and sliding the assembly forward. Tighten the two captive mounting screws and connect the ground wire to the monitor box chassis.

4.35.10 Connect the BP cuff tubing to the hose barb on the pump assembly and install a new tie-wrap clamp (later models use a spring-type hose clamp).

4.35.11 Connect the ribbon cable from the backplane to the assembly.

4.35.12 Restore power to the machine and run the NIBP diagnostics test given in Section 2 to verify that the replacement assembly is working properly.

4.35.13 Set the System Power switch on the front panel to the STANDBY position and remove AC power from the machine.

4.35.14 Replace the monitor box cover and connect the remote display cable, BP cuff and BP gauge lines and the oximeter sensor cable at the left side panel of the monitor box. Replace the disposable reservoir.

4.35.15 Perform the PMS Procedure given in Section 6.

## 4.36 Pulse Oximeter (SpO2) Assembly

The location of the pulse oximeter assembly within the monitor box is shown in Figure 4-36. Typical assemblies are illustrated; there may be variations in the circuit board arrangements and the shape of the mounting bracket. The monitor box cover must be removed to gain access to this assembly.

4.36.1 Turn the System Power switch on the front panel to the STANDBY position and remove AC power from the machine.

CAUTION: Do not plug or unplug remote display with power applied.

4.36.2 Disconnect the following items from the patient interface panel on the left side of the monitor box:
- -Remote Display and Datagrip cables
- -Pulse Oximeter Sensor cable
- -BP Cuff and BP Gauge lines

4.36.3 Remove the disposable reservoir from its holder.

4.36.4 Remove the screws holding the monitor box cover, and carefully lift the cover from the monitor box.

4.36.5 Disconnect all backplane wire harnesses and cables to the $SpO_2$ assembly, and disconnect the interface panel cable.

4.36.6 Loosen the two captive screws holding the assembly to the monitor box, and remove the assembly. On later designs the $SpO_2$ assembly is located next to the gas analyzer, and the speaker is located on the card cage assembly.

4.36.7 Install the replacement assembly in the same position as the original.

4.36.8 Connect the interface panel cable, and connect the backplane wire harnesses and cables to the assembly as shown in the illustration. (On earlier models without the speaker amplifier board, ensure that the black wire is connected to the (+) speaker terminal.)

4.36.9 Restore power to the machine and run the $SpO_2$ diagnostics test given in Section 2 to verify that the replacement assembly is working properly.

4.36.10 Set the System Power switch on the front panel to the STANDBY position and remove AC power from the machine.

4.36.11 Replace the monitor box cover and connect the remote display cable, BP cuff and BP gauge lines and the oximeter sensor cable at the left side panel of the monitor box. Replace the disposable reservoir.

4.36.12 Perform the PMS Procedure given in Section 6.

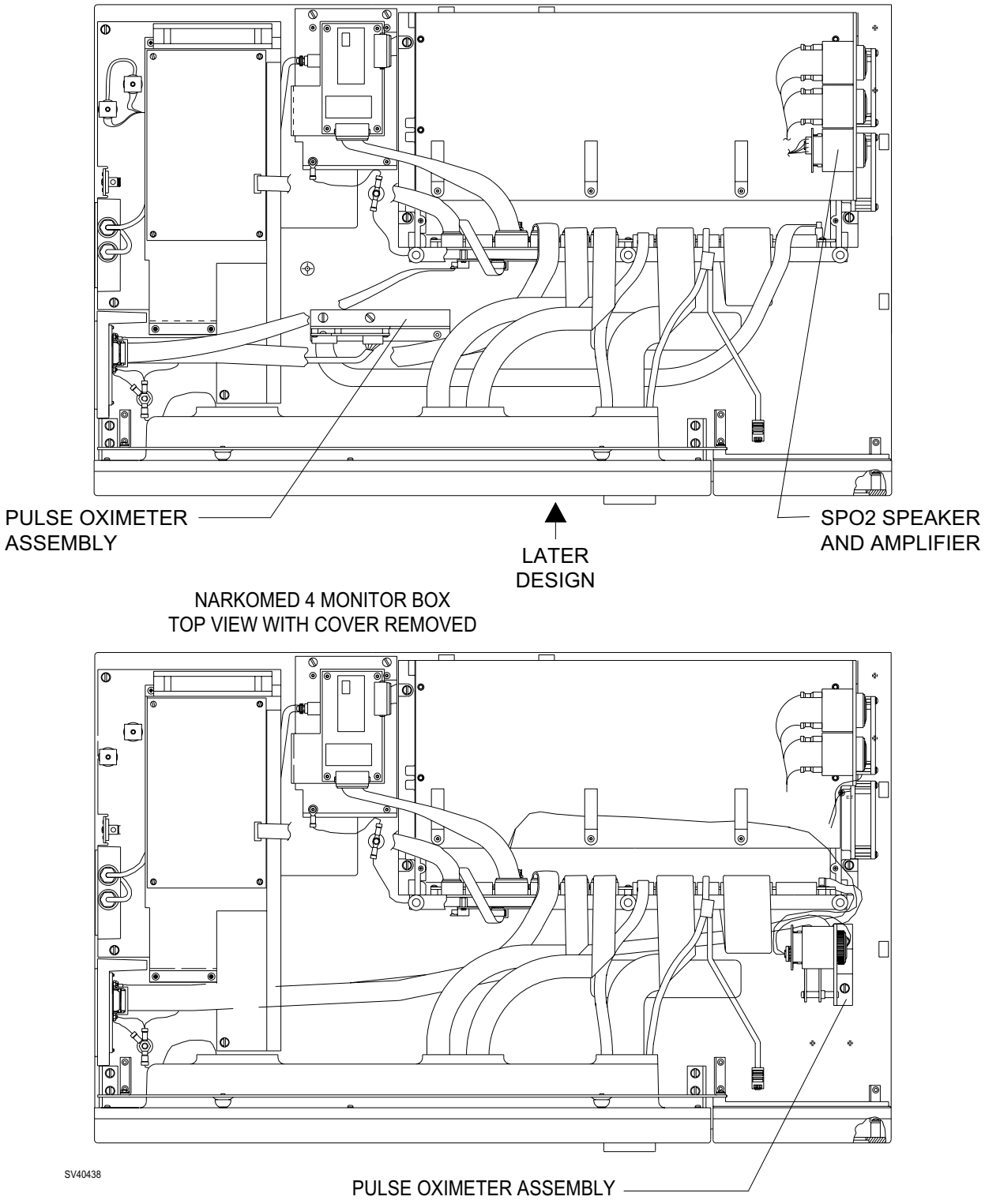



**Figure 4-36: PULSE OXIMETER ASSEMBLY LOCATION**

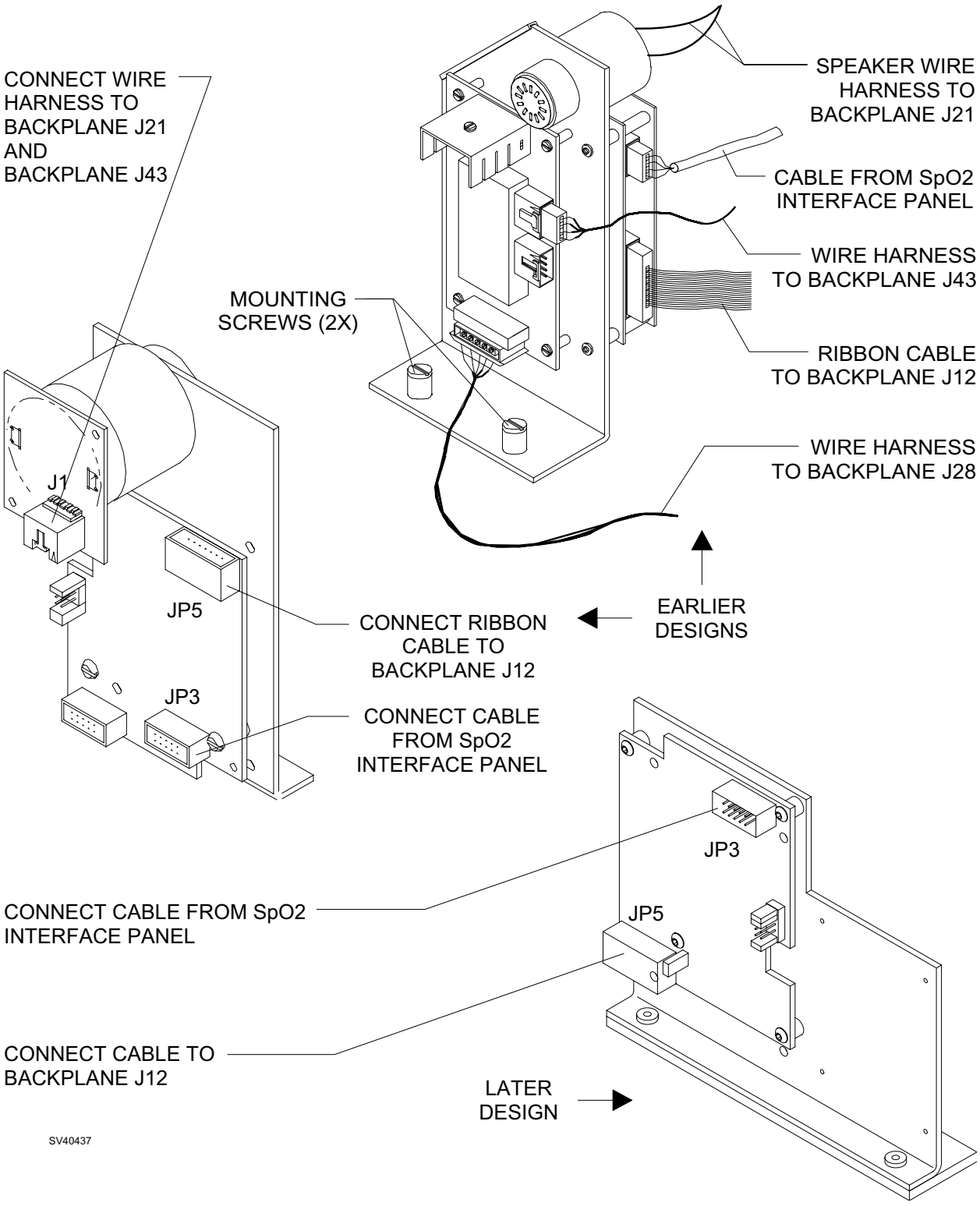
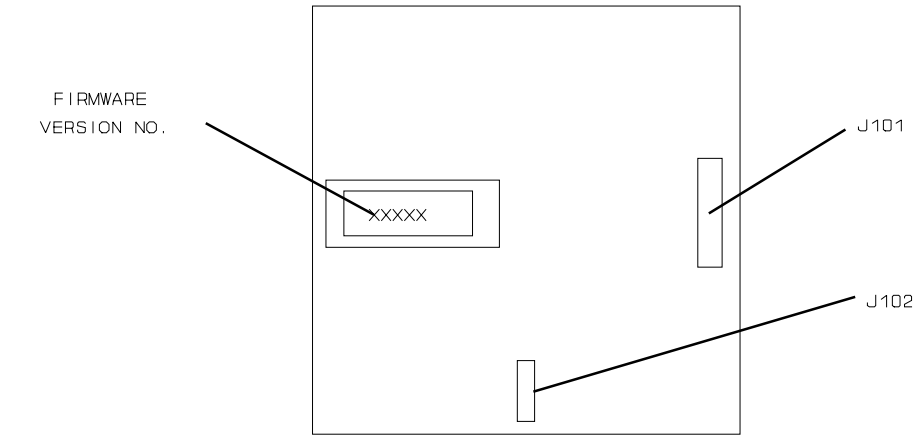
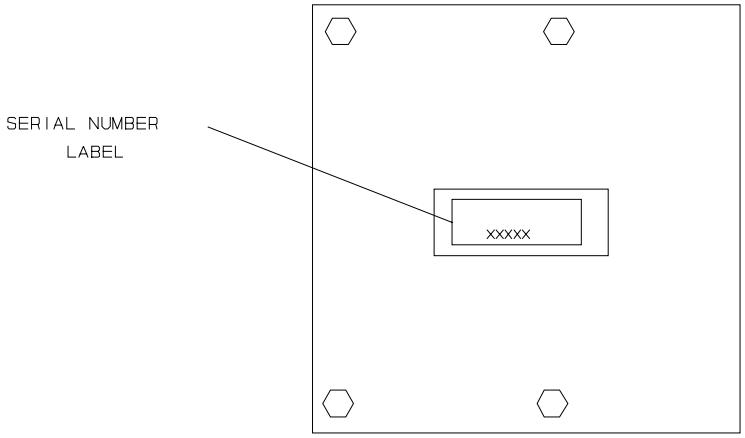



**Figure 4-36: (continued) PULSE OXIMETER ASSEMBLY**




NOVAMETRIX SPO2 MODULE
(COMPONENT SIDE)




NOVAMETRIX SPO2 MODULE
(SHIELD PLATE SIDE)

**Figure 4-36: (continued) NOVAMETRIX PULSE OXIMETER MODULE**

## 4.37 VPO Assembly

The VPO assembly is located in a box at the back of the machine as shown in Figure 4-37. Access to the VPO assembly requires removal of a cover plate and removal of the AC power inlet filter from the VPO box.

4.37.1 Set the System Power switch on the front panel to the STANDBY position and remove AC power from the machine.

4.37.2 Remove the AC power cable from the power inlet on the bottom of the VPO box.

WARNING: Ensure that AC power is removed from the machine before opening the VPO box cover. Failure to observe this precaution may cause injury by electric shock.

4.37.3 Remove the six screws holding the cover plate over the wiring channel and VPO box, and remove the cover plate.

4.37.4 Disconnect the following items from the sensor interface panel:

-$O_2$ Sensor cable

-Volume Sensor cable

-Breathing Pressure monitor cable

-Exhaust tubing

4.37.5 Remove the line, neutral and ground wires from the terminals of the EMI filter.

4.37.6 Remove the two screws holding the EMI filter to the bottom of the VPO box, and remove the EMI filter.

4.37.7 Remove the screw holding the ground wire to the VPO assembly.

4.37.8 Remove the eight connector panel screws.

CAUTION: The VPO circuit board contains static sensitive devices. Use ESD protection when handling the VPO assembly.

4.37.9 Carefully move cabling aside to provide clearance for the VPO assembly, and remove the assembly from the box.

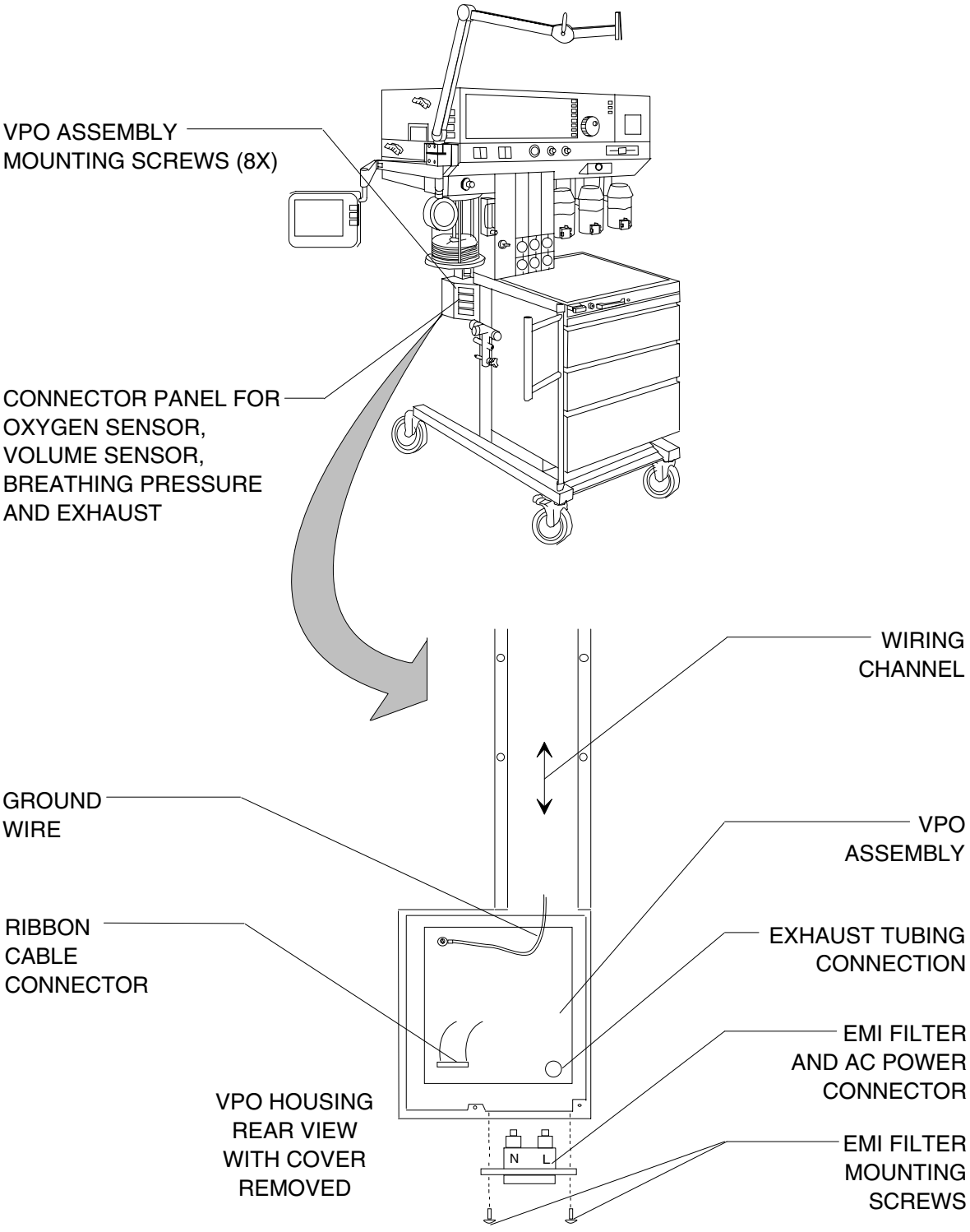



**Figure 4-37: VPO ASSEMBLY**

4.37.10 Disconnect the ribbon cable and the exhaust tubing from the VPO assembly.

4.37.11 Connect the ribbon cable and the exhaust tubing to the replacement VPO assembly.

4.37.12 Place the assembly in the box, align the connector panels with the box cutouts and install the eight connector panel screws.

4.37.13 Connect the ground wire to the VPO assembly.

WARNING: The AC power wiring must be connected to the EMI filter in the correct polarity. Incorrect connection will compromise the electrical safety of the machine.

4.37.14 Install the EMI filter in the bottom of the VPO box and connect the line, neutral and ground wires to the terminals as follows:

-Green/yellow wire to Ground terminal

-Blue wire to Neutral terminal

-Brown wire to Line terminal

4.37.15 Install the cover plate over the wiring channel and back of the VPO box.

4.37.16 Connect the $O_2$ Sensor, Volume Sensor, Breathing Pressure cables, and the exhaust tubing to the sensor interface panel.

4.37.17 Connect the AC power cable to the power inlet on the bottom of the VPO box.

4.37.18 Restore power to the machine and run the Oxygen, Pressure and Respiratory Flow diagnostics given in Section 2 to verify that the replacement VPO assembly is working properly.

4.37.19 Perform the PMS Procedure given in Section 6.

## 4.38 SPIROMED Respiratory Volume Sensor

The respiratory volume sensor is installed between the top of the absorber assembly and the expiratory valve. Figure 4-38 shows the volume sensor mounting arrangement, gaskets and connection to the VPO panel.

4.38.1 Set the System Power switch to STANDBY.

4.38.2 Disconnect the sensor plug from the volume sensor receptacle on the VPO panel.

4.38.3 Remove the expiratory valve by unscrewing the valve retaining nut.

4.38.4 Remove the volume sensor from the absorber assembly by unscrewing its retaining nut.

CAUTION: Do not twist the body of the sensor when loosening the retaining nut. Hold the sensor while loosening the retaining nut to prevent damage to the unit.

4.38.5 Install the replacement volume sensor on the absorber assembly. Ensure that the gasket is seated properly and hand tighten the retaining nut.

4.38.6 Install the expiratory valve on the sensor. Ensure that the gasket is seated properly and hand tighten the valve retaining nut.

4.38.7 Connect the sensor plug to the volume sensor receptacle on the VPO panel.

4.38.8 Restore power to the machine and perform the respiratory flow monitor calibration procedure given in Section 5.

4.38.9 Perform the PMS Procedure given in Section 6.

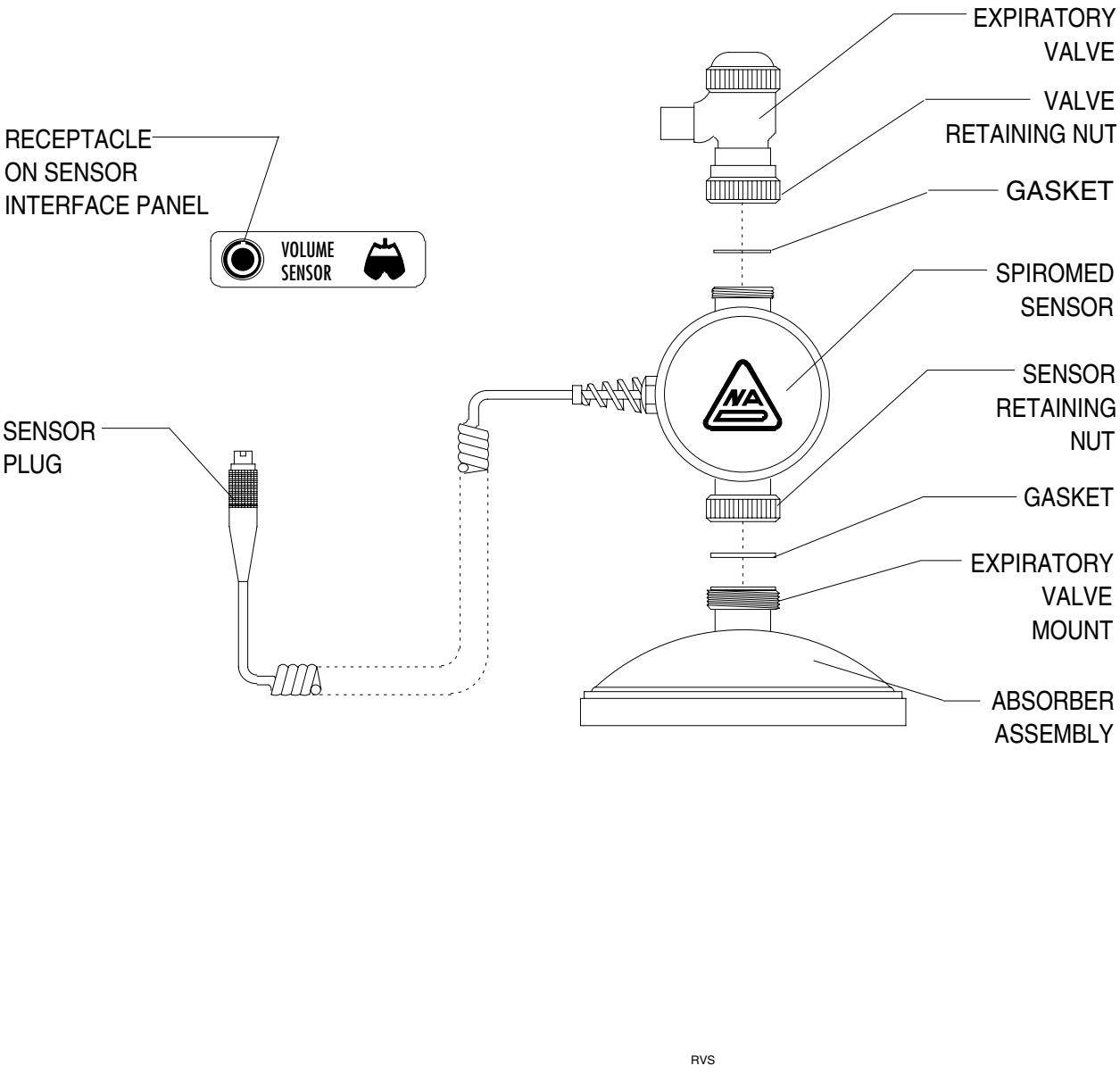



**Figure 4-38: RESPIRATORY VOLUME SENSOR**

## 4.39 Oxygen Sensor

The oxygen sensor is located on top of the inspiratory valve. Figure 4-39 shows the arrangement of the sensor capsule and its housing, and also its connection to the VPO (interface) panel.

4.39.1 Set the System Power switch to STANDBY.

4.39.2 Pull the oxygen sensor housing from the inspiratory valve dome. (It is a press fit.)

4.39.3 Unscrew the cover from the sensor housing and remove the sensor capsule.

4.39.4 Remove the replacement sensor capsule from its shipping container and install it in the housing. Ensure that the copper rings on the capsule mate with the electrical contacts in the sensor housing.

4.39.5 Wait 15 minutes to allow the sensor capsule to stabilize.

4.39.6 Restore power to the machine and perform the ambient air calibration given in Section 5.

4.39.7 Press the sensor assembly into the inspiratory valve dome.

4.39.8 Perform the PMS Procedure given in Section 6.

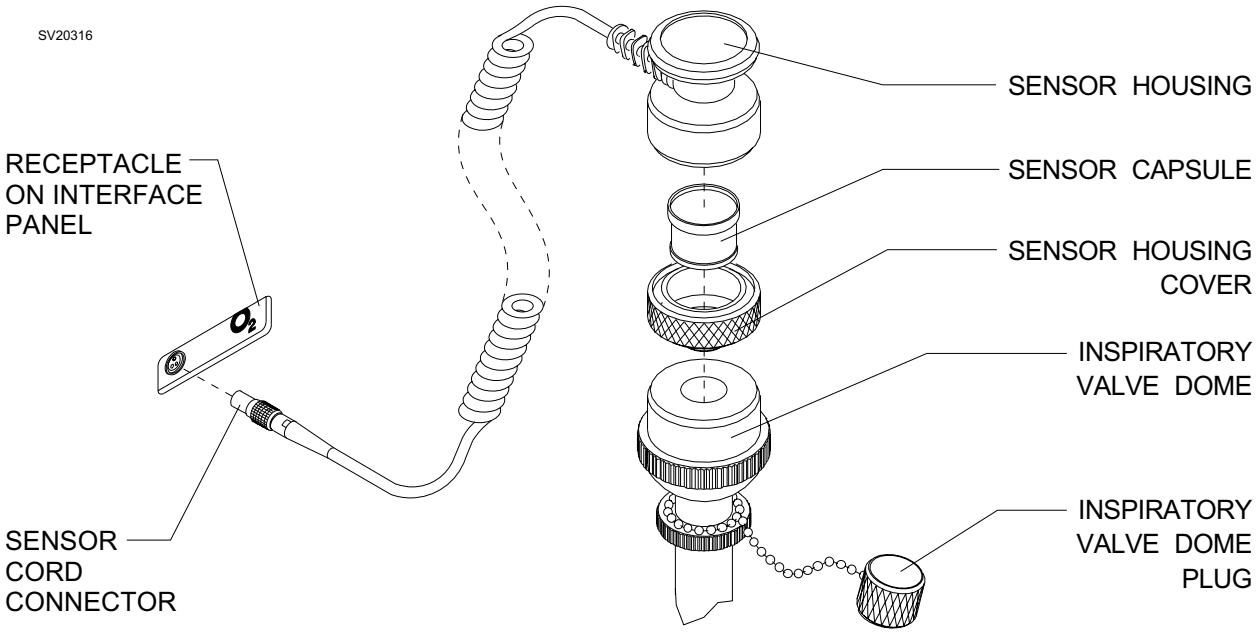



**Figure 4-39: OXYGEN SENSOR REPLACEMENT**

## 4.40 Manual Sphygmomanometer

The manual sphygmomanometer gauge is mounted on a threaded piece attached to the underside of the boom arm mounting block. On later machines the gauge mount is attached to the display arm support plate. Figure 4-40 shows the gauge mounting arrangements, and the gauge connection to the patient interface panel.

4.40.1 Disconnect the gauge line from the BP GAUGE fitting on the patient interface panel.

4.40.2 Remove the gauge by unscrewing its mounting ring from the fitting on the boom arm mounting block.

4.40.3 Install the replacement gauge on the threaded fitting on the boom arm mounting block, and hand tighten the gauge mounting ring.

4.40.4 Connect the gauge line to the BP GAUGE fitting on the patient interface panel.

4.40.5 Ensure that the remaining connections are properly made:

Connect the hose on the blood pressure cuff to an extension hose, and the other end of the extension hose to the BP CUFF fitting on the patient interface panel.

Connect the inflation bulb hose to the BP BULB fitting on the front of the machine.

4.40.6 Perform the following leak test on the manual sphygmomanometer:

4.40.6.1 Place the blood pressure cuff around a rigid cylindrical object approximately the same diameter as a human arm.

4.40.6.2 Inflate the cuff to a pressure of 200 mm Hg, as indicated on the gauge.

4.40.6.3 The pressure should not drop more than 10 mm Hg in 30 seconds.

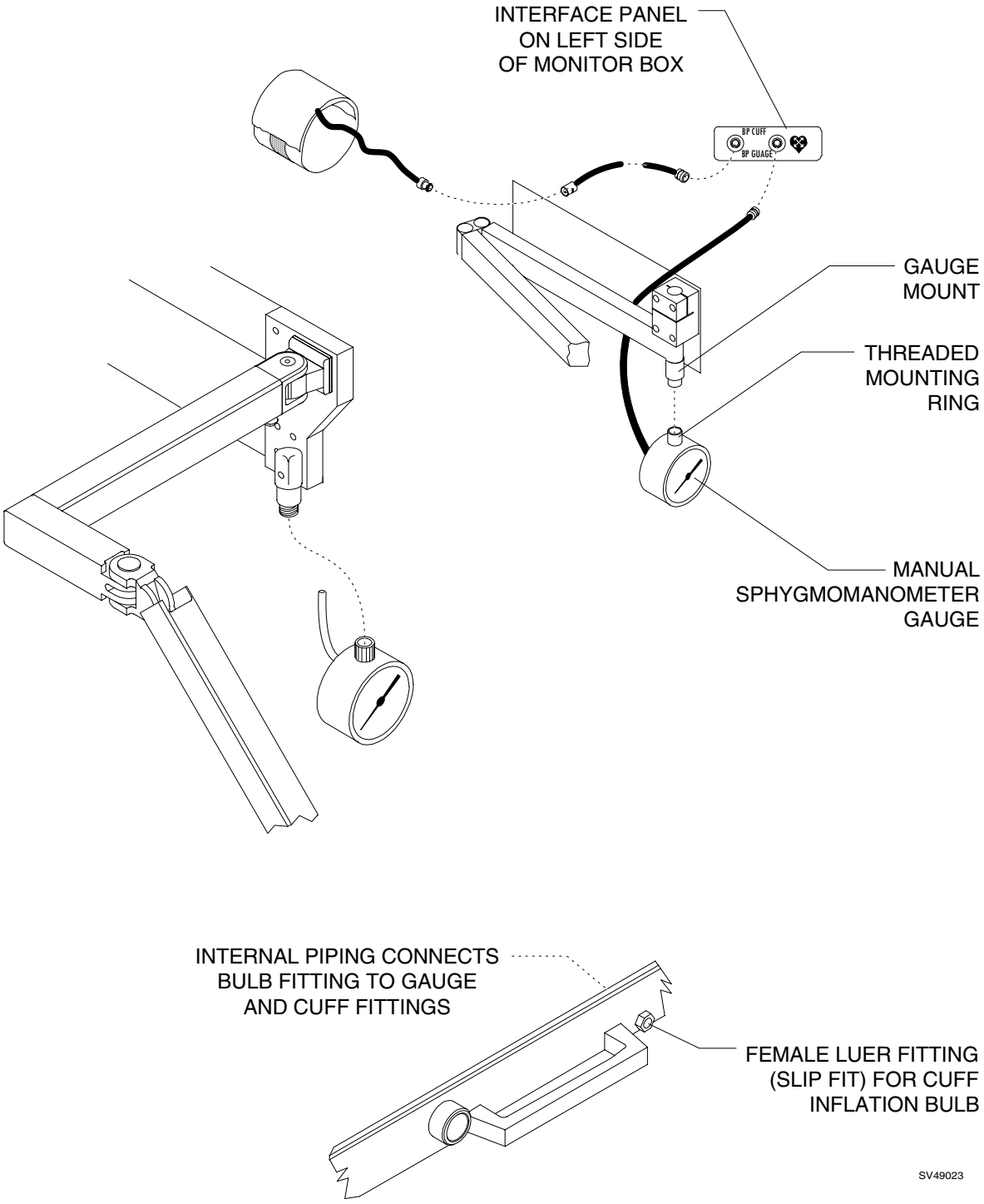



**Figure 4-40: MANUAL SPHYGMOMANOMETER**

## 4.41 Boom Arm Assembly (earlier machines)

The boom arm is supported by a mounting block attached on the left side of the machine. This mounting block is part of the boom arm assembly and is attached to the machine by four socket head screws. Before removing the boom arm from the machine, the Datagrip and remote display assembly must be removed from the outboard end of the arm. If the machine is equipped with an optional manual sphygmomanometer, the gauge must be removed from the boom arm mounting block. Figure 4-41 shows the boom arm mounting arrangement.

4.41.1 Set the System Power switch to STANDBY.

CAUTION: Do not plug or unplug remote display with power applied.

4.41.2 Disconnect the Datagrip and remote display cables from the patient interface panel on the left side of the monitor box.

4.41.3 Loosen the cable clamps along the boom arm and separate the cables from the boom arm.

4.41.4 Remove the plastic cap at the end of the boom arm to expose the Datagrip and remote display assembly mounting screw.

4.41.5 While holding the remote display, loosen its mounting screw until the display assembly separates from the boom arm.

4.41.6 If the anesthesia equipment has an optional manual sphygmomanometer gauge, disconnect its tubing and remove the gauge by unscrewing its mounting ring.

4.41.7 While holding the boom arm, remove the screws holding the mounting block to the machine.

4.41.8 Hold the replacement boom arm in place and secure the mounting block to the machine with the screws that were previously removed. Install the long screw (¼-20 x 1¾ in.) in the upper right hole, and the ¼-20 x 1 in. screws in the remaining three holes.

4.41.9 Reinstall the Datagrip and remote display assembly to the boom arm and tighten its mounting screw to a torque of 3 to 5 foot pounds. Replace the plastic cap covering the mounting screw recess.

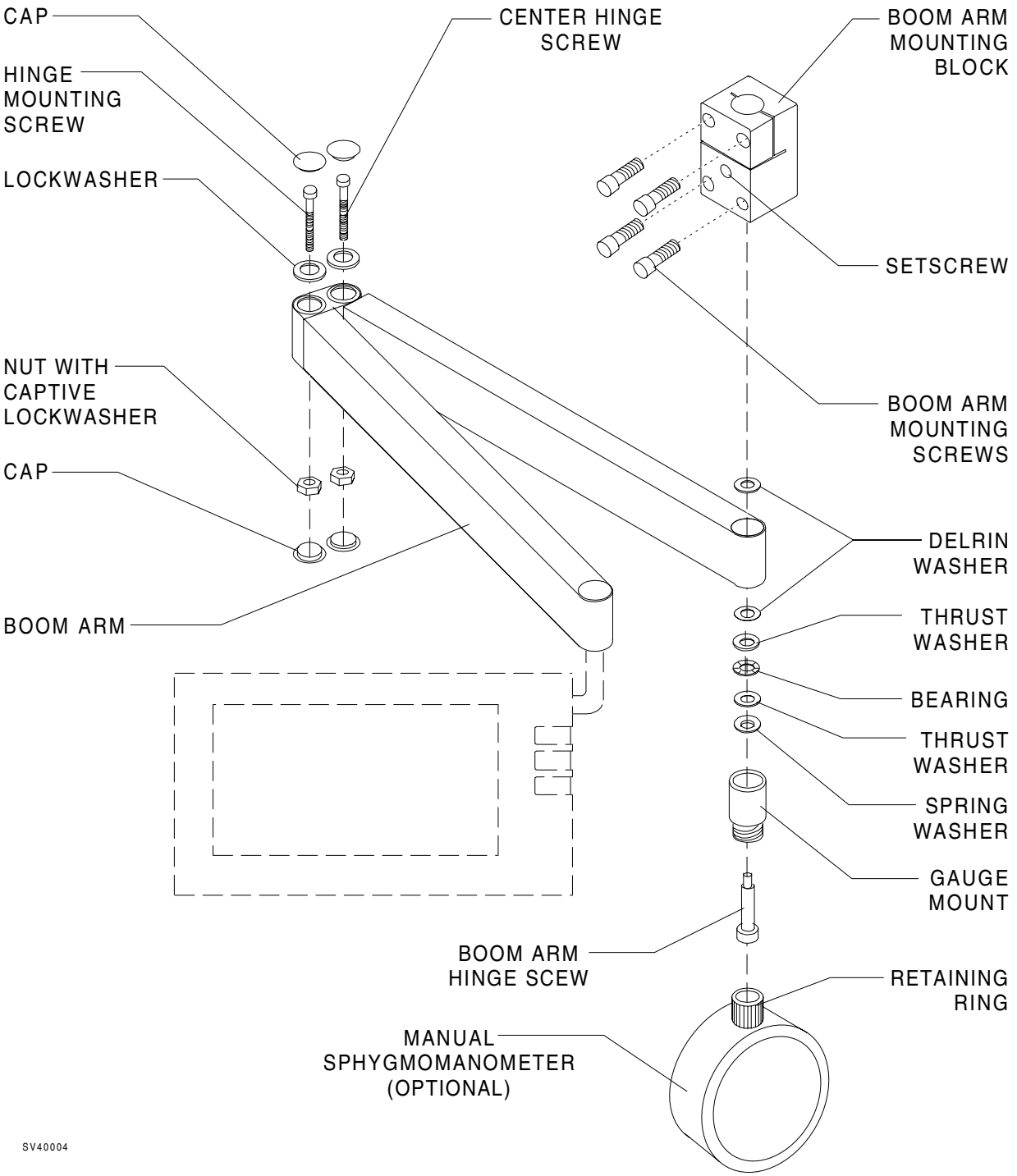



**Figure 4-41: BOOM ARM ASSEMBLY**

4.41.10 Install the remote display and Datagrip cables in the retainer clamps along the boom arm.

4.41.11 Connect the remote display and Datagrip cables to the patient interface panel on the left side of the monitor box.

4.41.12 If tension adjustments to the boom arm hinges are needed, refer to the adjustment procedure in Section 5 of this manual.

4.41.13 If applicable, reinstall the manual sphygmomanometer gauge.

4.41.14 Restore power to the machine and verify that the Datagrip and remote display are working properly.

4.41.15 Perform the PMS Procedure given in Section 6.

## 4.42 Display Arm Assembly (later machines)

This procedure applies to both the adjustable arm and the short arm.

The display arm assembly includes a support plate that attaches to the left side of the machine with socket head screws that thread into the bellows box and ventilator box. Before removing the display arm from the machine, the Datagrip and remote display assembly must be removed from the outboard end of the arm. Figure 4-42 shows a typical display arm mounting arrangement. Figure 4-42A shows the cable routing arrangement for the adjustable arm, and Figure 4-42B shwos the cable routing arrangement for the short arm.

Refer to Figure 4-42C for installations with an optional patient line boom arm.

4.42.1 Turn the System Power switch to STANDBY.

CAUTION: Do not plug or unplug remote display with power applied.

4.42.2 Disconnect the remote display and Datagrip cables from their ports on the left side of the monitor box.

4.42.3 Remove the screws holding the cable clamps along the display arm and separate the cables from the display arm.

4.42.4 Remove the plastic cap at the end of the display arm to expose the Datagrip assembly mounting screw.

4.42.5 While holding the Datagrip assembly, loosen the mounting screw until the assembly separates from the display arm.

WARNING: Do not attempt to disassemble the display arm sections. Release of the internal spring may cause injury to personel.

4.42.6 While holding the display arm, remove the six screws holding its support plate to the side of the machine.

. . . . . .

NOTE: If the replacement display arm hardware was not pre-assembled, refer to Service Procedure SP00114 for assembly details.

4.42.7 Hold the replacement display arm assembly in place and secure the support plate to the machine with the screws that were previously removed. If the machine is equipped with a manual sphygmomanometer, the longer screw is used to secure the gauge mount at the lower front corner of the support plate.

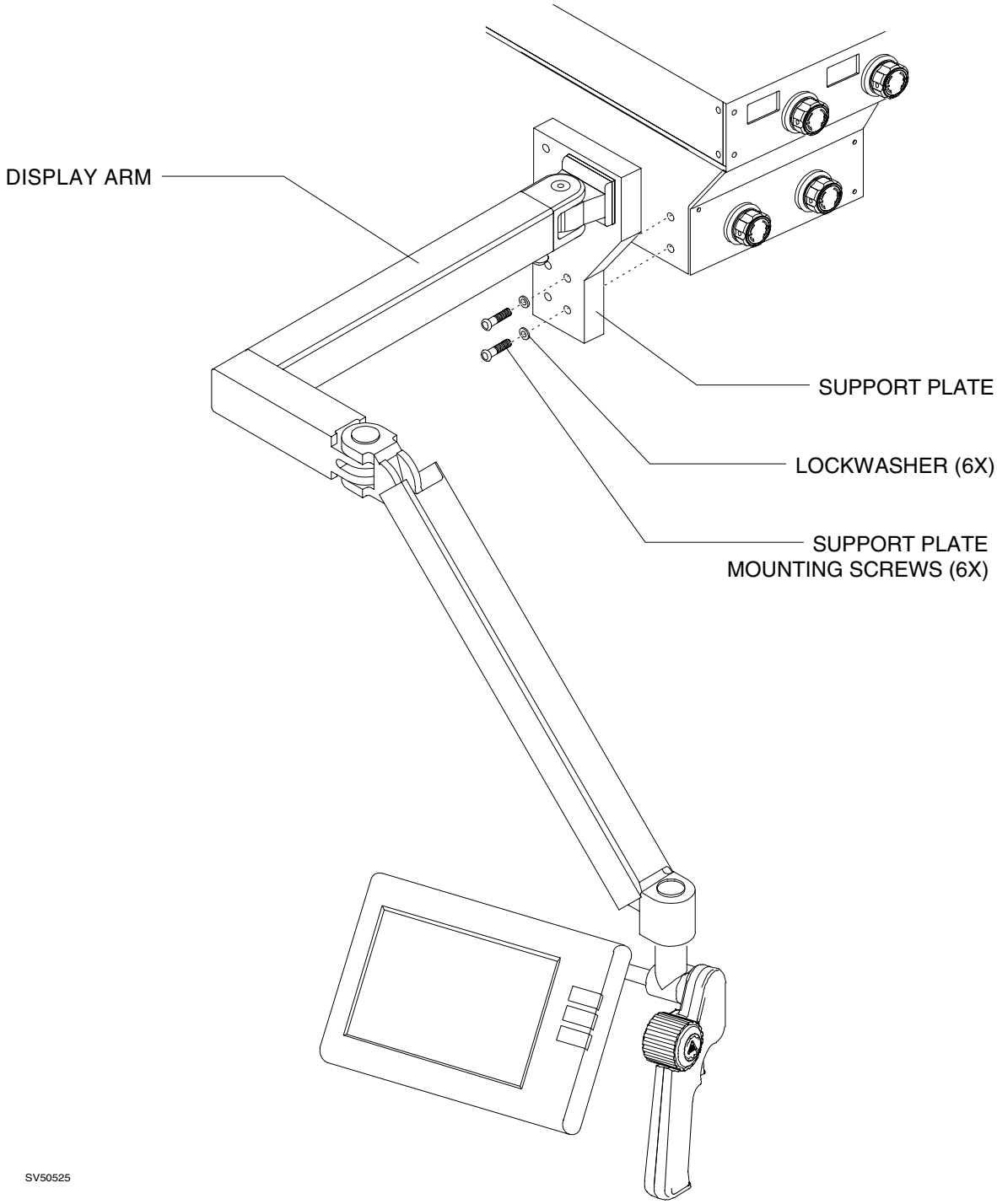



**Figure 4-42: DISPLAY ARM**

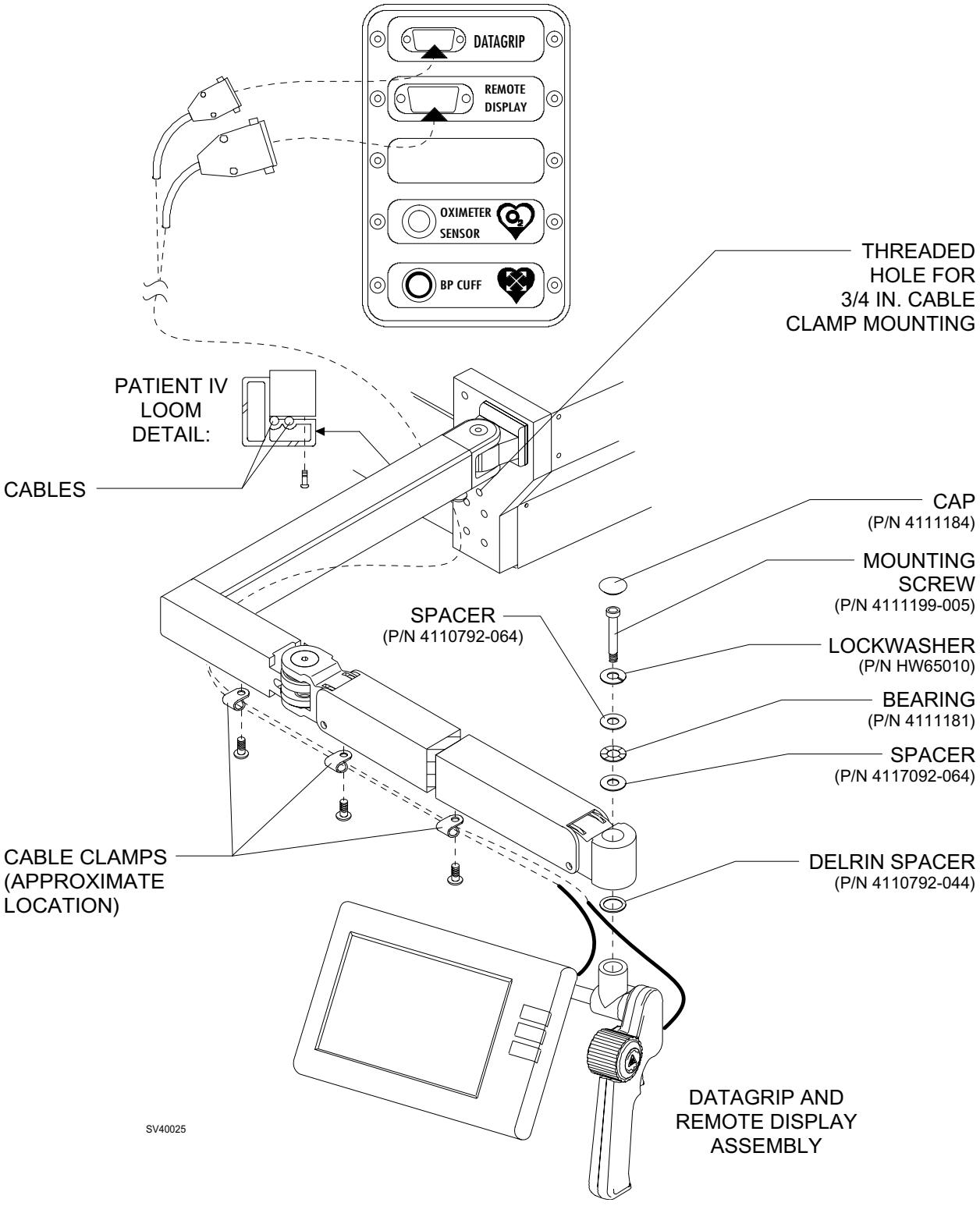



**Figure 4-42A: CABLE ROUTING ARRANGEMENT FOR ADJUSTABLE DISPLAY ARM**

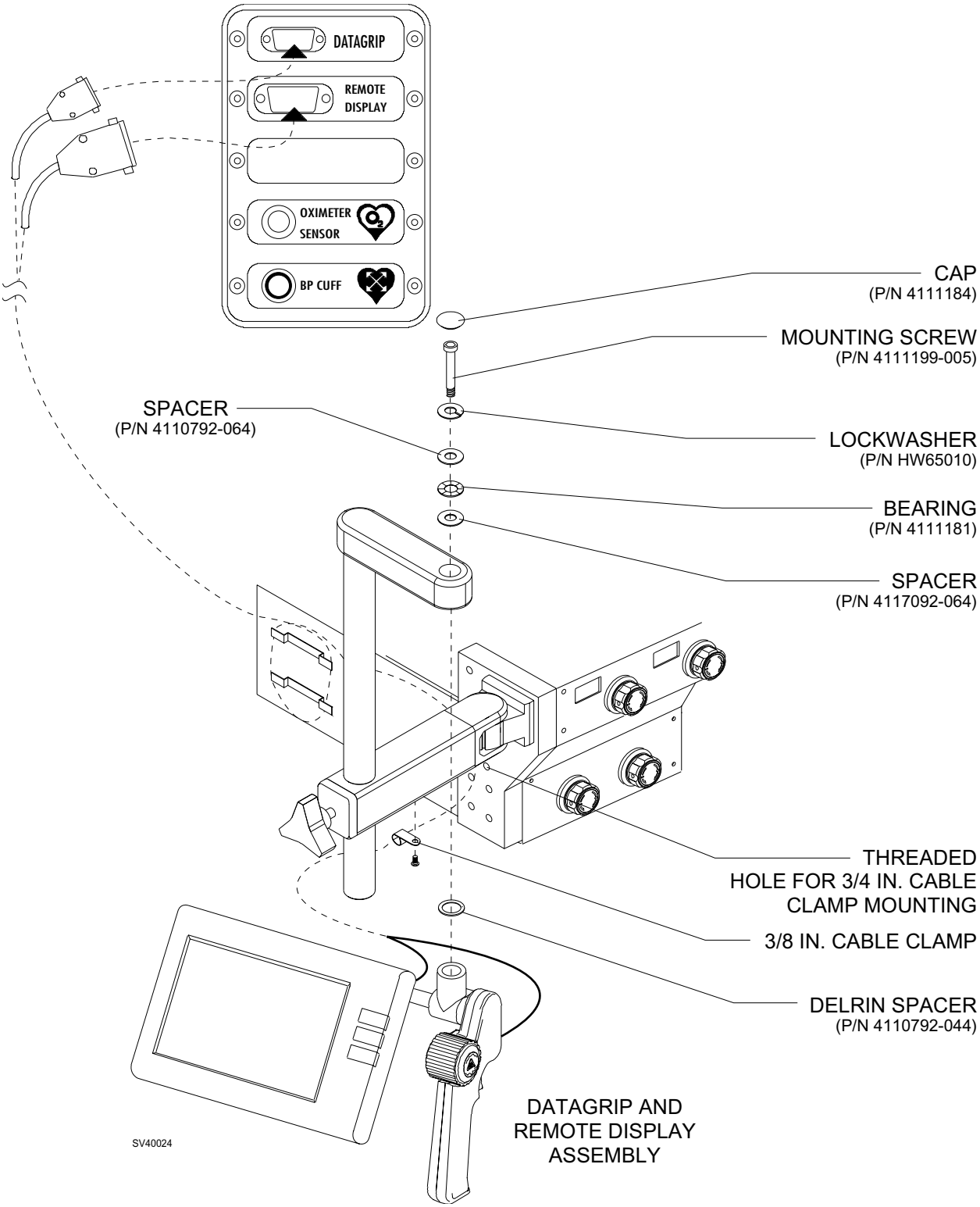



**Figure 4-42B: CABLE ROUTING ARRANGEMENT FOR SHORT DISPLAY ARM**

4.42.8 Reinstall the Datagrip and remote display assembly to the display arm and tighten its mounting screw to a torque of 4 foot pounds. Replace the plastic cap covering the mounting screw recess.

4.42.9 Route the cables as shown in the applicable illustration. For the adjustable arm, coil the excess cable in the patient IV looms. For the short arm, coil the excess cable around the cord wraps on the bellows box.

4.42.10 Connect the remote display and Datagrip cables to their ports on the left side of the monitor box. Verify that the arm and the Datagrip have full range of motion with no binding caused by the cables. Position the cables in their clamps as needed.

4.42.11 If tension adjustment is needed on the adjustable display arm hinge, refer to the adjustment procedure in Section 5 of this manual.

4.42.12 Restore power to the machine and verify that the Datagrip and remote display are working properly.

4.42.13 Perform the PMS Procedure given in Section 6.

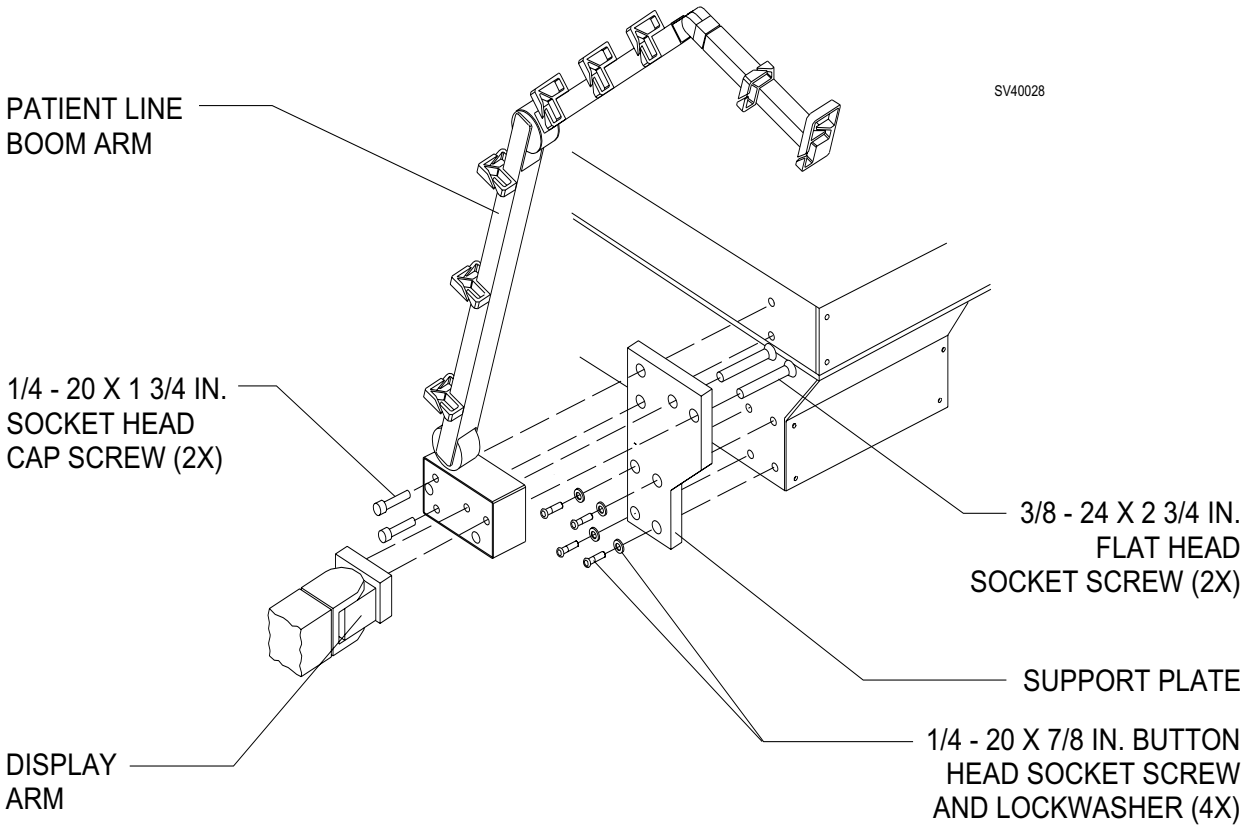



**Figure 4-42C: OPTIONAL PATIENT LINE BOOM ARM ASSEMBLY DETAILS**

## 4.43 Internal Strip Chart Printer

The internal strip chart printer can be removed from the monitor box at the front panel. Figure 4-43 shows the location of the printer mounting screws that are accessible with the printer door open.

4.43.1 Set the System Power switch to STANDBY.

4.43.2 Press the right side of the release bar to open the printer door.

4.43.3 Loosen the two captive mounting screws at the back of the printer.

4.43.4 Carefully withdraw the printer forward through the panel opening and disconnect the ribbon cable at the back of the printer.

4.43.5 Connect the ribbon cable to the replacement printer and slide the unit through the panel opening until it is seated against its mounting bracket.

NOTE: If the replacement printer is a later model (P/N 4112048), remove the jumper from J19 pins 1 & 2 on the backplane PCB assembly. Refer to Section 4-24 for access to the backplane PCB assembly.

4.43.6 Tighten the captive mounting screws at the back of the printer; DO NOT apply more than 8 in.lbs. of torque.

4.43.7 Load the printer with paper and close the door.

4.43.8 Perform the PMS Procedure given in Section 6.

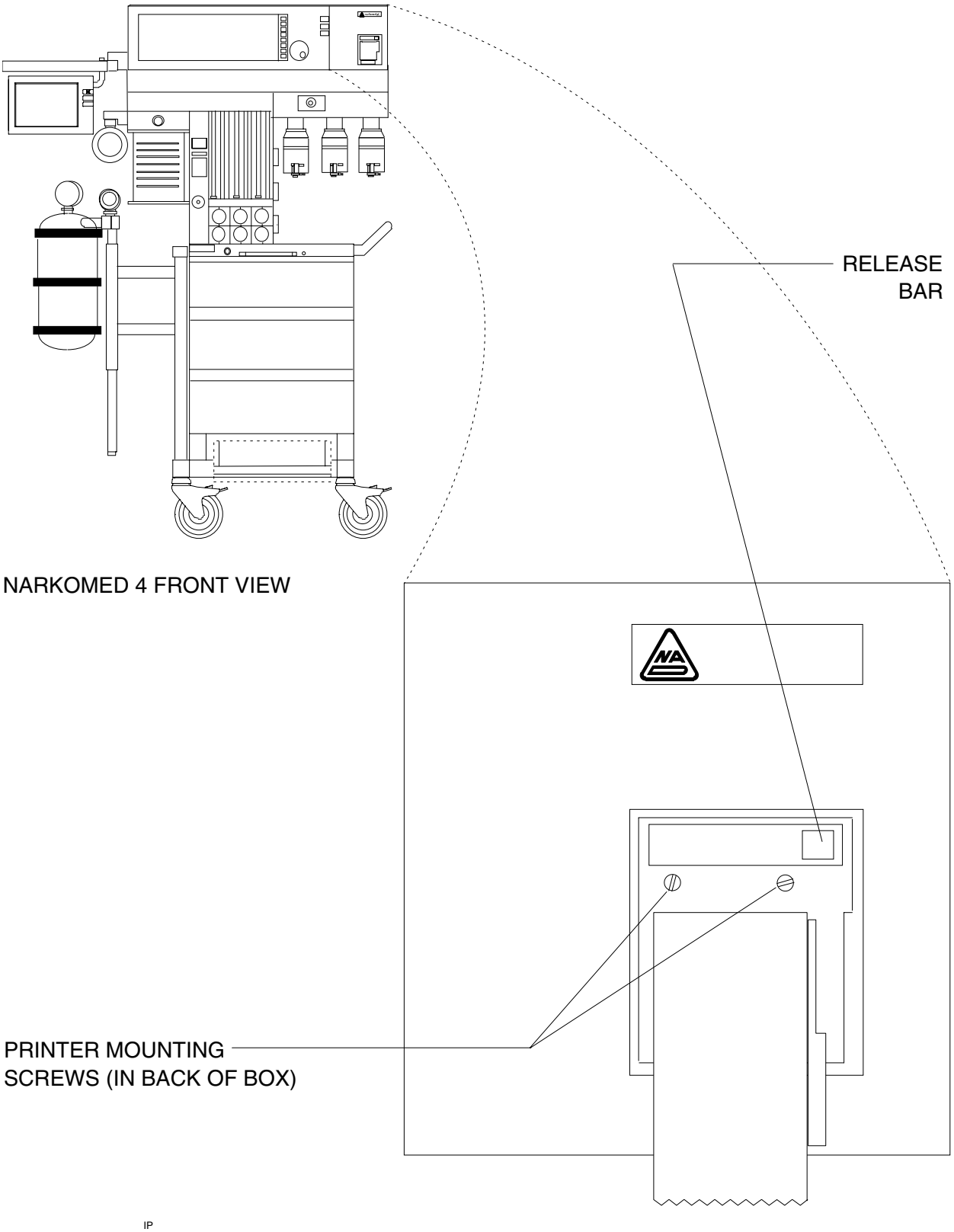



**Figure 4-43: INTERNAL PRINTER**

## 4.44 O.R. DATA MANAGER CPU Assembly (earlier machines)

The O.R. DATA MANAGER (ORDM) CPU assembly is located in the right side of the ventilator box. Access to the ORDM CPU assembly requires removal of the right front panel of the ventilator box, and removal of the monitor box cover. Figure 4-44 shows the CPU assembly mounting and cable connection arrangement. The lower PC board contains a 3-volt lithium battery that provides data retention when power is removed from the CPU. The location and orientation of the battery are shown in the illustration.

4.44.1 Set the System Power switch to STANDBY and remove AC power from the machine.

4.44.2 Remove any disk from the disk drive.

4.44.3 Remove the four screws holding the right front panel of the ventilator box, and remove the panel.

CAUTION: Use ESD protection when handling the CPU assembly.

4.44.4 Loosen the two captive mounting screws holding the ORDM CPU assembly to the floor of the ventilator box. Carefully slide the CPU assembly forward.

4.44.5 Disconnect all cables from the patient interface panel on the left side of the monitor box.

4.44.6 Remove the six screws holding the monitor box cover, and carefully lift the cover from the monitor box.

4.44.7 Disconnect the ORDM cables from backplane connectors J3, J13, and J14.

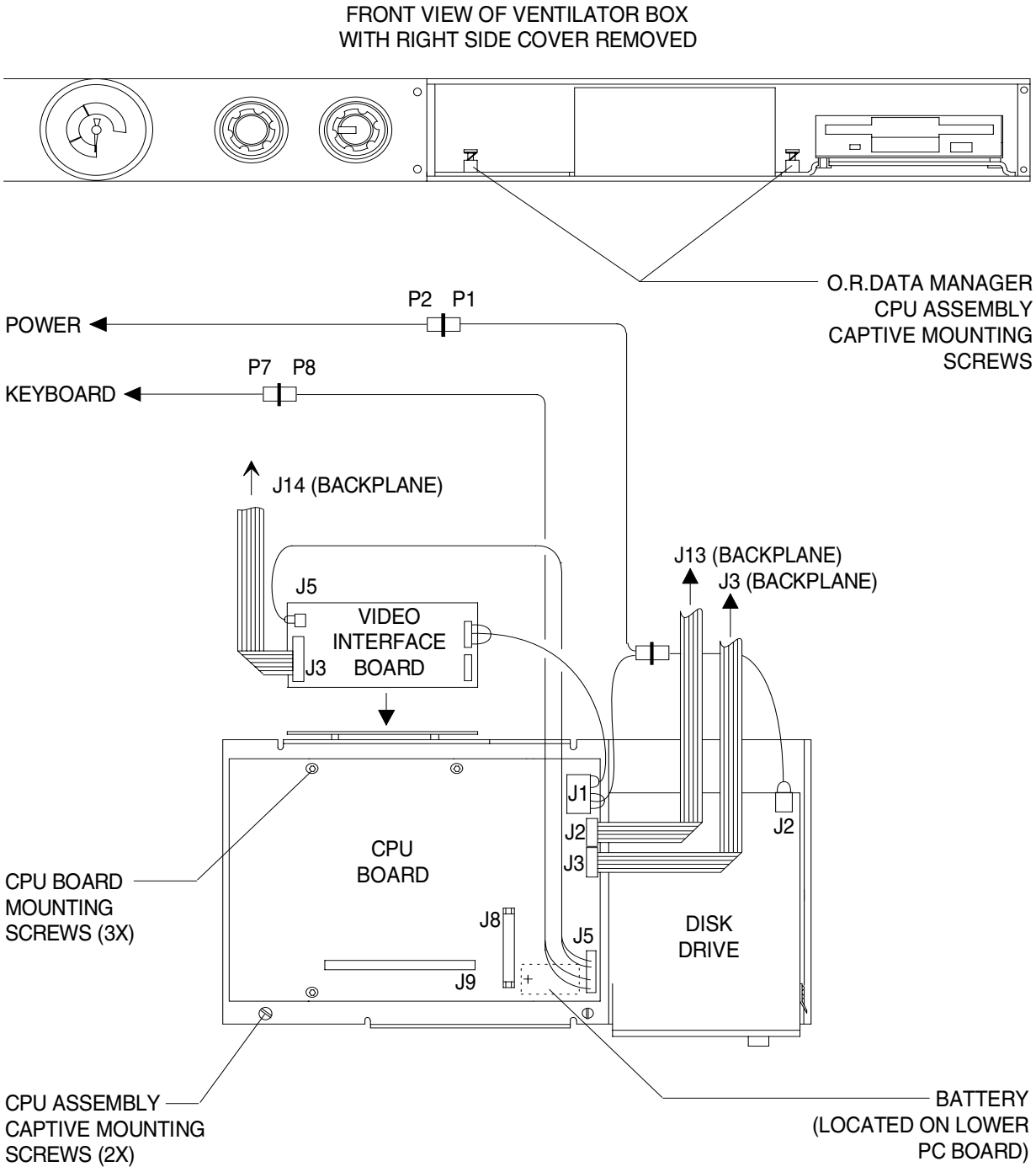
4.44.8 Disconnect the keyboard cable floating connector (P7-P8), and the power wire harness floating connector (P2-P1).

4.44.9 Carefully pull the ORDM CPU assembly from the ventilator box.

NOTE: The next step refers to memory battery replacement only. Skip this step if the entire ORDM CPU assembly is being replaced.

4.44.10 Battery Replacement

4.44.10.1 Disconnect the ribbon cables from J8 and J9 on the CPU board.




TOP VIEW OF O.R.DATA MANAGER CPU ASSEMBLY

**Figure 4-44: O.R. DATA MANAGER CPU ASSEMBLY CONNECTIONS**

4.44.10.2 Remove the three CPU board mounting screws and carefully set the board aside.

CAUTION: Be sure to install the battery in its proper orientation, as reversed polarity could damage the CPU circuitry.

4.44.10.3 Remove the battery from its holder and install a replacement battery.

4.44.10.4 Mount the CPU board to the CPU assembly with the three screws that were previously removed, and re-connect the ribbon cables to J8 and J9 on the CPU board.

4.44.11 Install the replacement ORDM CPU assembly into the ventilator box. Feed the cables up through the hole into the monitor box and around the right side of the backplane.

4.44.12 Join the ORDM keyboard floating connector (P7-P8), and the power wire harness floating connector (P2-P1). Connect the remaining ORDM cables to backplane connectors J3, J13, and J14.

4.44.13 Reinstall the monitor box cover and restore all connections to the patient interface panel.

4.44.14 Carefully slide the CPU assembly into position in the ventilator box and fasten the captive mounting screws.

4.44.15 Replace the ventilator box right side front panel and secure it with its four mounting screws.

4.44.16 Insert the O.R. DATA MANAGER Program Disk into the disk drive. Restore power to the machine and set the System Power switch to ON.

4.44.17 Follow the ORDM boot information that appears on the Remote Display.

4.44.18 Perform the PMS procedure given in Section 6.

## 4.45 O.R. DATA MANAGER Sub-Assembly (later machines)

The O.R. DATA MANAGER sub-assembly is located behind the right front ventilator box cover. Replacement of the ORDM requires removal of the monitor box cover and disconnecting the ORDM cables. The ORDM can then be withdrawn from the front of the ventilator box for access to the remaining cables. Figure 4-45 shows the ORDM mounting and cable connection arrangement.

4.45.1 Turn the System Power switch to STANDBY and remove AC power from the machine.

4.45.2 Remove any disk from the disk drive.

CAUTION: Use ESD protection when handling the ORDM sub-assembly.

4.45.3 Disconnect all cables from the patient interface panel on the left side of the monitor box.

4.45.4 Remove the six screws holding the monitor box cover, and carefully lift the cover from the monitor box.

4.45.5 Disconnect the ORDM cables from backplane connectors J3, J13, and J14.

4.45.6 Disconnect the ORDM Datagrip cable from Datagrip PCB J3 (located on the front of the backplane).

4.45.7 Disconnect the power wire harness floating connector.

4.45.8 Disconnect the keyboard cable floating connector.

4.45.9 Remove the right front ventilator box cover.

On later machines with an AV-2 ventilator, remove the two screws securing the right end of the ORDM front bezel. Pull the right side of the bezel outward, slide it to the right until the locking tab on the left side of the bezel is clear of its receptacle, and remove the bezel.

4.45.10 Loosen the two captive mounting screws securing the ORDM sub-assembly to the ventilator box.

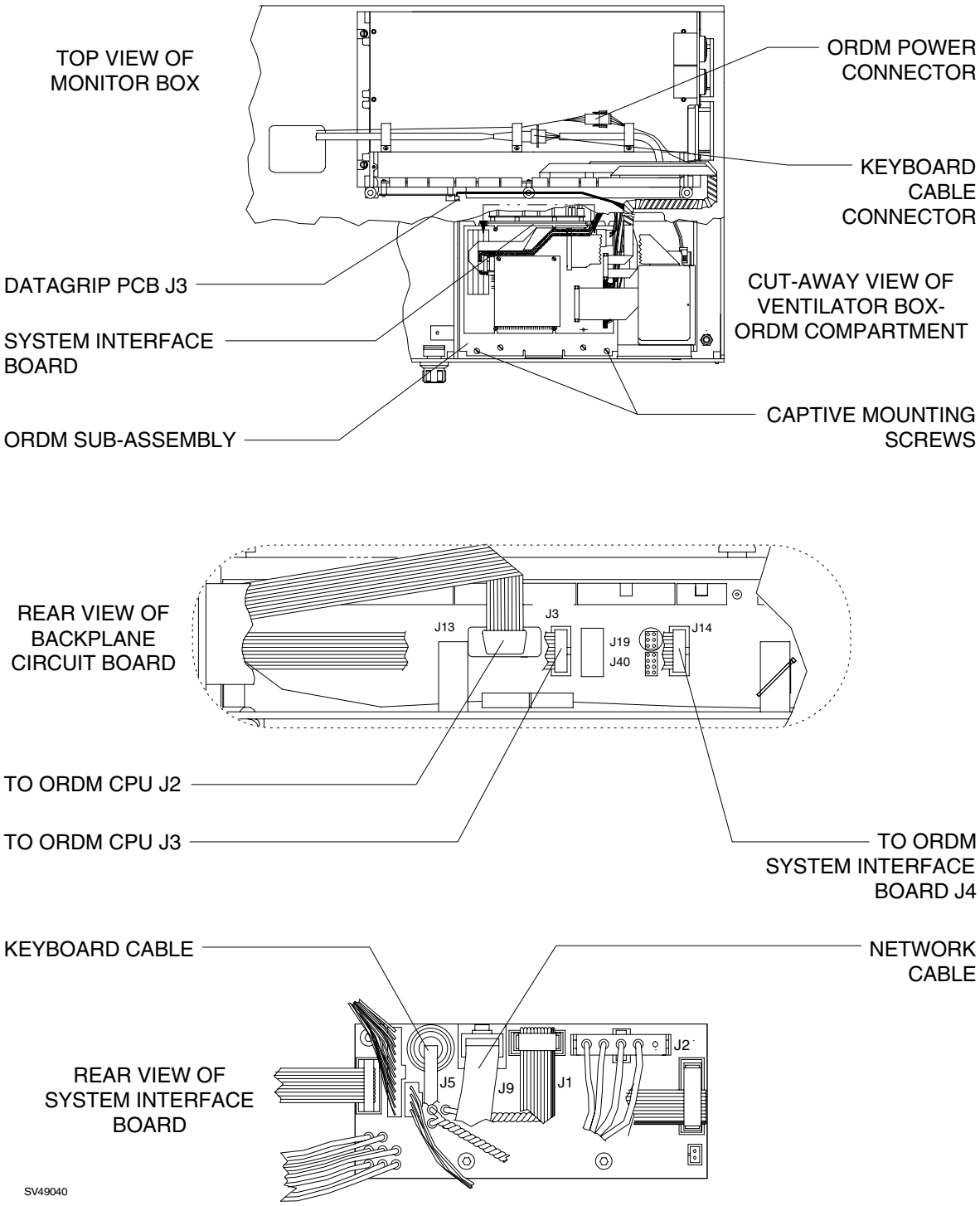



**Figure 4-45: ORDM SUB-ASSEMBLY CONNECTIONS**

4.45.11 Carefully pull the ORDM sub-assembly from the ventilator box while feeding the previously disconnected cables down from the monitor box.

As the ORDM is pulled out, disconnect the network cable from J9 on the system interface board.

4.45.12 Transfer the backplane, power and Datagrip cables to the replacement ORDM sub-assembly.

4.45.13 Connect the network cable to J9 on the replacement ORDM system interface board. Feed the ORDM cables up into the monitor box while sliding the ORDM sub-assembly into place in the ventilator box.

4.45.14 When the ORDM sub-assembly is correctly positioned, tighten its captive mounting screws to secure it to the ventilator box.

4.45.15 Connect the power wire harness at the floating connector.

4.45.16 Connect the floating keyboard cable connector. Route the power wire harness and the keyboard cable through the cable clamps on the backplane assembly.

4.45.17 Connect the ORDM Datagrip cable to J3 on the Datagrip PCB (located on the front of the backplane).

4.45.18 Connect the ORDM cables to J3, J13 and J14 on the backplane.

4.45.19 Reinstall the right front ventilator box cover.

4.45.20 Reinstall the monitor box cover and restore all connections to the patient interface panel.

4.45.21 Insert the O.R. DATA MANAGER Program Disk into the disk drive. Restore power to the machine and turn the System Power switch to ON.

4.45.22 Follow the ORDM boot information that appears on the Remote Display.

4.45.23 Perform the PMS Procedure given in Section 6.

## 4.46 Keyboard

The keyboard is mounted on a pull-out tray assembly located just below the table top of the anesthesia equipment cabinet. The keys are covered by a polyurethane shield formed to fit over the keys. This shield is held in place by a self-adhesive strip around its perimeter and can be replaced without removing the keyboard from the tray. Figure 4-46 shows the keyboard assembly sequence. Following are the steps needed for removal and replacement of the keyboard.

4.46.1 Set the System Power switch to STANDBY.

4.46.2 Pull the keyboard tray out to its fully extended position, and carefully remove the polyurethane shield by separating its adhesive perimeter from the keyboard faceplate.

4.46.3 Remove the four faceplate retaining screws.

4.46.4 Remove the three drawer lip retaining screws and lift the faceplate from the keyboard.

4.46.5 Disconnect the cable from the keyboard and carefully lift the keyboard from the pull-out tray.

4.46.6 Carefully lower the replacement keyboard into the pull-out tray and connect the cable.

4.46.7 Place the faceplate over the keyboard and install the four faceplate retaining screws.

4.46.8 Install the three drawer lip retaining screws.

4.46.9 Fit a new polyurethane shield over the keys and press its adhesive perimeter firmly onto the faceplate.

4.46.10 Perform the PMS procedure given in Section 6.

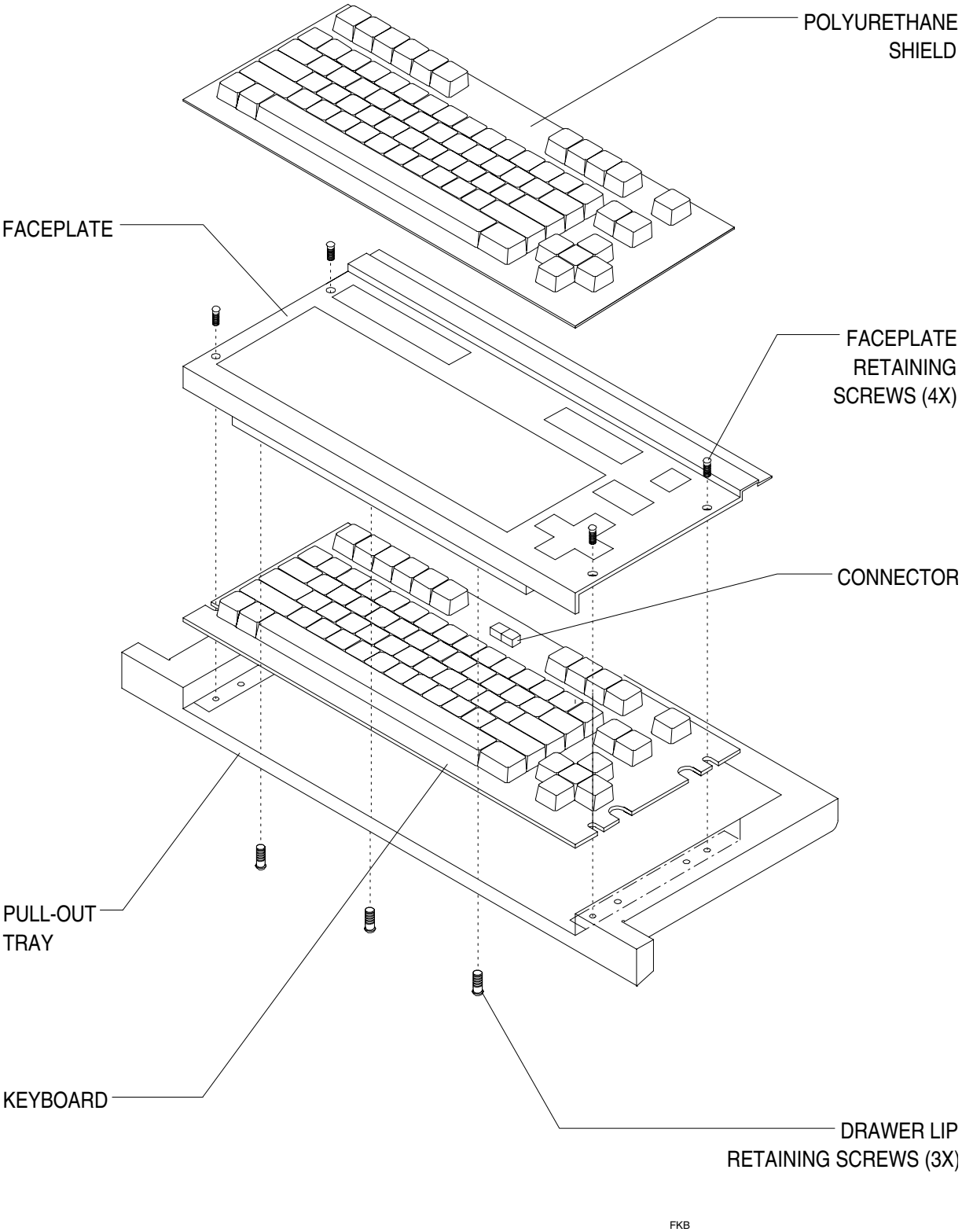



**Figure 4-46: KEYBOARD ASSEMBLY**

## 4.47 Auxiliary Oxygen Flow Meter

Old and new style auxiliary oxygen flowmeters are attached to the side of the machine's flowmeter housing by two screws - accessible from inside the housing. Later installations of the new style auxiliary oxygen flowmeter have a stud and nut arrangement for mounting. A flexible $O_2$ supply tube from the flowmeter connects to a hose barb fitting at the system power switch. Figure 4-47 shows a typical mounting and tubing arrangement.

4.47.1 Disconnect all pipeline hoses and close all cylinder valves.

4.47.2 Press the $O_2$ Flush button to drain oxygen pressure from the system.

4.47.3 Turn the System Power switch to STANDBY and remove AC power from the machine.

4.47.4 Remove the back cover from the flowmeter housing.

4.47.5 Cut the tie strap on the flexible tube at the system power switch, and remove the tube.

4.47.6 Remove the screws (or nuts) securing the auxiliary $O_2$ flowmeter, and remove the flowmeter.

4.47.7 Position the replacement flowmeter at the side of the flowmeter housing (feed the flex tubing through the clearance hole) and secure the auxiliary $O_2$ flowmeter with the two screws (or nuts) that were previously removed.

4.47.8 Connect the flex tubing to the hose barb fitting behind the Clippard valve, and secure it with a tie strap.

4.47.9 Reinstall the flowmeter housing back cover.

4.47.10 Connect the pipeline hoses and restore AC power to the machine.

4.47.11 Perform the PMS Procedure given in Section 6.

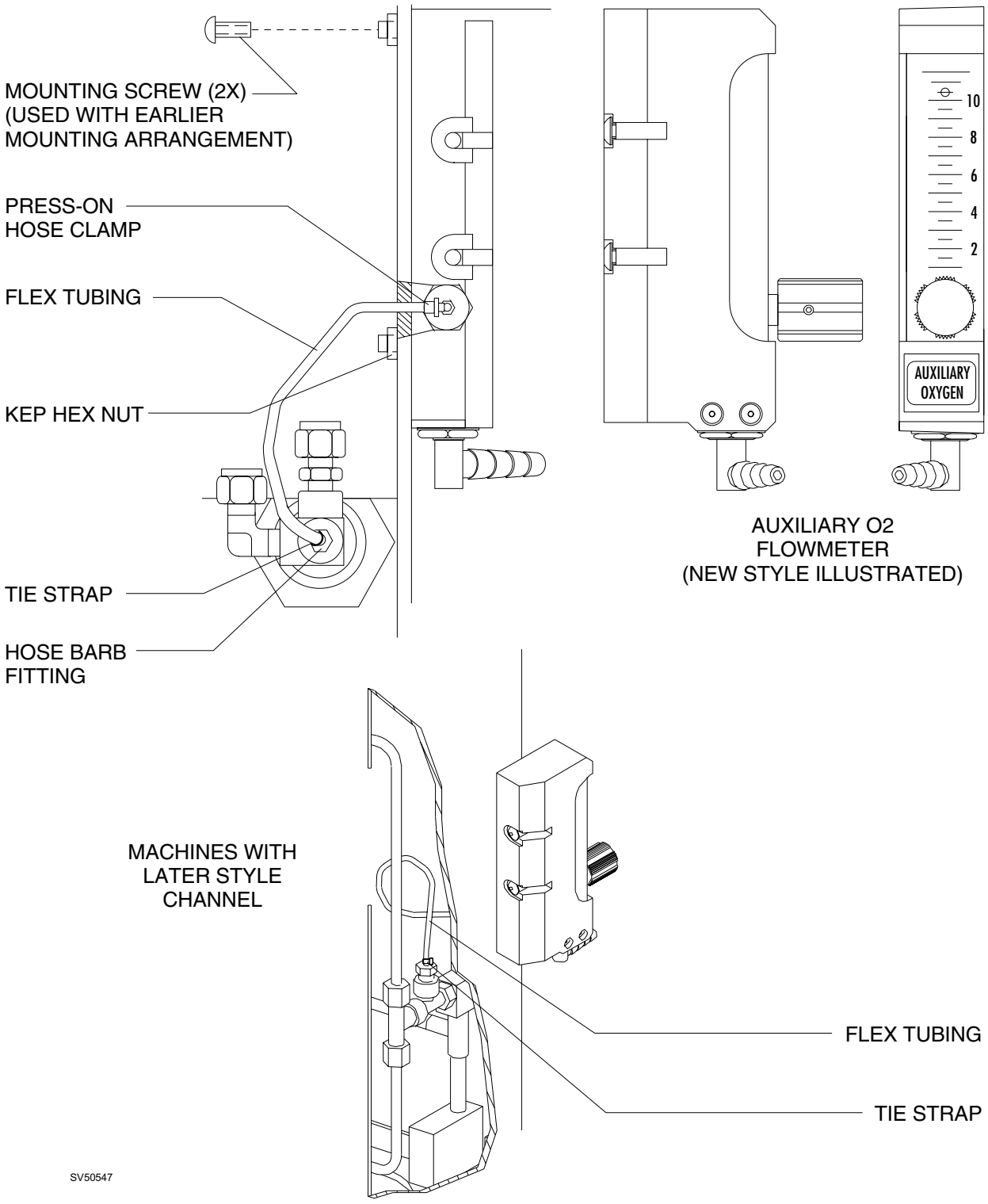



**Figure 4-47: AUXILIARY $O_2$ FLOWMETER**

## 4.48 PEEP Valve Magnet Assembly Replacement

The PEEP valve magnet assembly removal and replacement is outlined in the following procedure. Figure 4-33 shows the knob and magnet assembly details.

NOTE: Some older PEEP valve assemblies require the use of a tamper-proof 5/56 hex key (P/N S010056).

4.48.1 Loosen the two set screws on the block, at each side of the PEEP knob using a 5/64 hex key. Back these screws out until they are flush with the block to allow proper removal of the knob assembly.

4.48.2 Using a flat head screw driver, carefully pry the knob and magnet assembly away from the block, and remove the assembly.

4.48.3 Remove the four or six screws securing the retaining ring on the knob and magnet assembly, and remove the retaining ring.

4.48.4 Remove the magnet assembly from the knob and discard the magnet in an appropriate manner.

4.48.5 Insert the new magnet assembly into the knob.

On new style knobs, make sure the magnet's dowel pin engages the slots in the knob. If the magnet is not oriented correctly there will be freeplay in the knob before it turns the magnet.

4.48.6 Reinstall the retaining ring and secure it with the screws that were previously removed.

4.48.7 Turn the set screws into the PEEP block until you can just see them from the inside of the block.

4.48.8 Apply a thin coat of high vacuum grease to the O-rings on the magnet assembly to aid in its installation.

4.48.9 Align the holes of the magnet assembly with the set screw holes, and install the knob & magnet assembly into the PEEP block.

4.48.10 Slowly tighten the set screws. If the holes are lined up correctly. you will be able to tighten the set screws several turns until they stop. If you experience resistance, STOP tightening the set screw to prevent damage to the magnet assembly. Re-align the magnet assembly and tighten the set screw correctly.

4.48.11 Perform the PMS procedure given in Section 6.

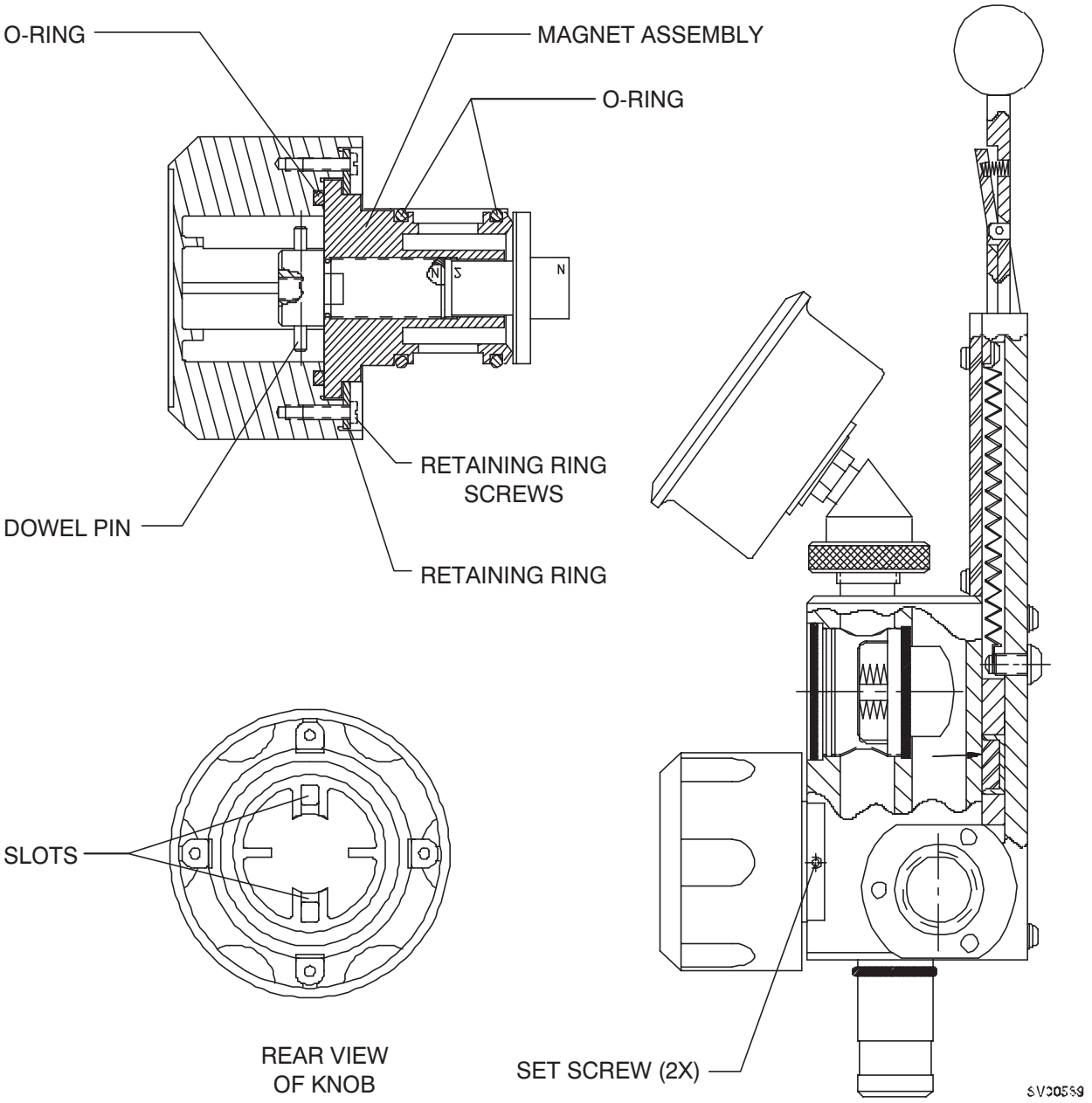



Figure 4-48: PEEP Valve Magnet Assembly Replacement

# 5.0 ADJUSTMENT AND CALIBRATION PROCEDURES

Equipment Required:

-- Test Gauge for setting cylinder pressure regulators, NAD Part No. S000063A

-- Oxygen Monitor for adjusting oxygen ratio controller

-- Torque wrench for setting boom arm tension

-- Calibration Gas Adapter, NAD Part No. 4110716

-- Calibration Gas Cylinder, NAD Part No. 4110599 or 4110599-001

-- Certified sample gas cylinder for Multispec accuracy check

-- Flowmeter Test Stand, NAD Part No. S000058

-- Nellcor® model PT-2500 Pocket Tester for $SpO_2$ calibration check

-- Test fixture with Luer fittings, TEE connector, and pressure gauge, for NIBP inflation pressure test

-- Test Hose, freshgas outlet to expiratory valve, for respiratory volume monitor calibration

-- Test fixture with breathing pressure line connector, TEE connector, gauge, and inflation device, for breathing pressure monitor calibration

-- Variable Flow Restrictor, NAD Part No. 4107995

-- 7/64 in. hex wrench for display arm friction adjustment

## 5.1 Cylinder Pressure Regulator Adjustment (except CO2)

5.1.1 Disconnect all pipeline hoses and set the System Power switch to ON.

5.1.2 Close all cylinder valves except the $O_2$ valve.

5.1.3 Set the oxygen flow to 4 liters per min.

5.1.4 Open the other gas flow control valves to drain pressure from the system.

5.1.5 Close the O2 cylinder valve. Close all of the flow control valves and press the $O_2$ Flush valve to drain oxygen pressure from the system.

5.1.6 Set the System Power switch to STANDBY.

5.1.7 Remove the table top from the machine and remove the top cabinet drawer. Pull the writing tray out out to its fully extended position.

NOTE: Minimum cylinder pressures for this adjustment shall be:
N2O & CO2: 600 psi; O2, Air, He, He/O2, N2: 1000 psi.

5.1.8 Locate the TEE fitting in the ¼ in. diameter regulator output line, and remove the plug from the TEE fitting.

5.1.9 Connect a test gauge to the TEE fitting.

NOTE: For gases other than O2, the O2 cylinder valve must be open to allow other gases to flow. For N2O regulator adjustment, open the N2O flow control valve completely; then open the O2 flow control valve until the N2O flow reaches 4 L/min.

5.1.10 Open the cylinder valve and set the System Power switch to ON.

5.1.11 Set the O2 flow to 4 L/min. (also set the N20 or other gas flow to 4 L/min. if these regulators are being adjusted).

5.1.12 Remove the acorn nut on the bottom of the regulator to expose the adjusting screw. For N2O, turn the screw until the test gauge indicates 46 psi. (50 psi for CSA machines.) For O2 and other gases, use the compensated regulator output setting based on the cylinder pressure given in the following table.

CAUTION: Based on information supplied by the cylinder regulator manufacturer, when the regulator is used for gases other than N2O or CO2, its output pressure will decrease 0.5 psi for every 100 psi increase in cylinder pressure above 1000 psi. Currently, these regulators are calibrated at 47 psi with a cylinder supply of 1000 psi. If a 2000 psi cylinder is then installed, the regulator output will be 42 psi. This change in output must be compensated for to provide accurate performance throughout the cylinder's working range.

NOTE: Cylinder pressure compensation for the N2O regulator is not required.

| Cylinder Pressure (psi) | Compensated Regulator Output Setting (psi) | Compensated Regulator Output Tolerances (-4, +2) |
|---|---|---|
| 2000 | 42 (*45) | 38 - 44 (*41 - 47) |
| 1800 | 43 (*46) | 39 - 45 (*42 - 48) |
| 1600 | 44 (*47) | 40 - 46 (*43 - 49) |
| 1400 | 45 (*48) | 41 - 47 (*44 - 50) |
| 1200 | 46 (*49) | 42 - 48 (*45 - 51) |
| 1000 | 47 (*50) | 43 - 49 (*46 - 52) |

* Canada Settings

NOTE: If the O2 cylinder regulator is adjusted according to the chart, perform the following test to verify that the Lo O2 supply alarm is not activated during ventilation.

Open the O2 cylinder valve, install a breathing circuit with test lung to absorber, and make the following settings:

MAN/AUTO selector to AUTO

Ventilator:
FREQUENCY: 10 BPM
I:E Ratio: 1:2
Tidal Volume: 1400 mL
PLC: MAX
INSP FLOW: HIGH

Set the Fresh Gas flow to 10 L/min.

Turn on the ventilator. While the ventilator is cycling, press the O2 flush button and verify that the Lo O2 Supply alarm is not activated. If the alarm is activated, refer to Section 5.2 for Oxygen Supply Pressure Alarm Switch Adjustment.

5.1.13 Replace the acorn nut on the bottom of the regulator.

5.1.14 Close the cylinder valve and allow pressure to drain from the system.

5.1.15 Close all of the flow control valves and set the System Power switch to STANDBY.

5.1.16 Disconnect the test gauge from the TEE fitting and replace the plug in the fitting.

5.1.17 Replace the table top and its retaining screws.

5.1.18 Replace the top drawer in the cabinet.

5.1.19 Connect the pipeline hoses.

5.1.20 Perform the PMS Procedure given in Section 6.

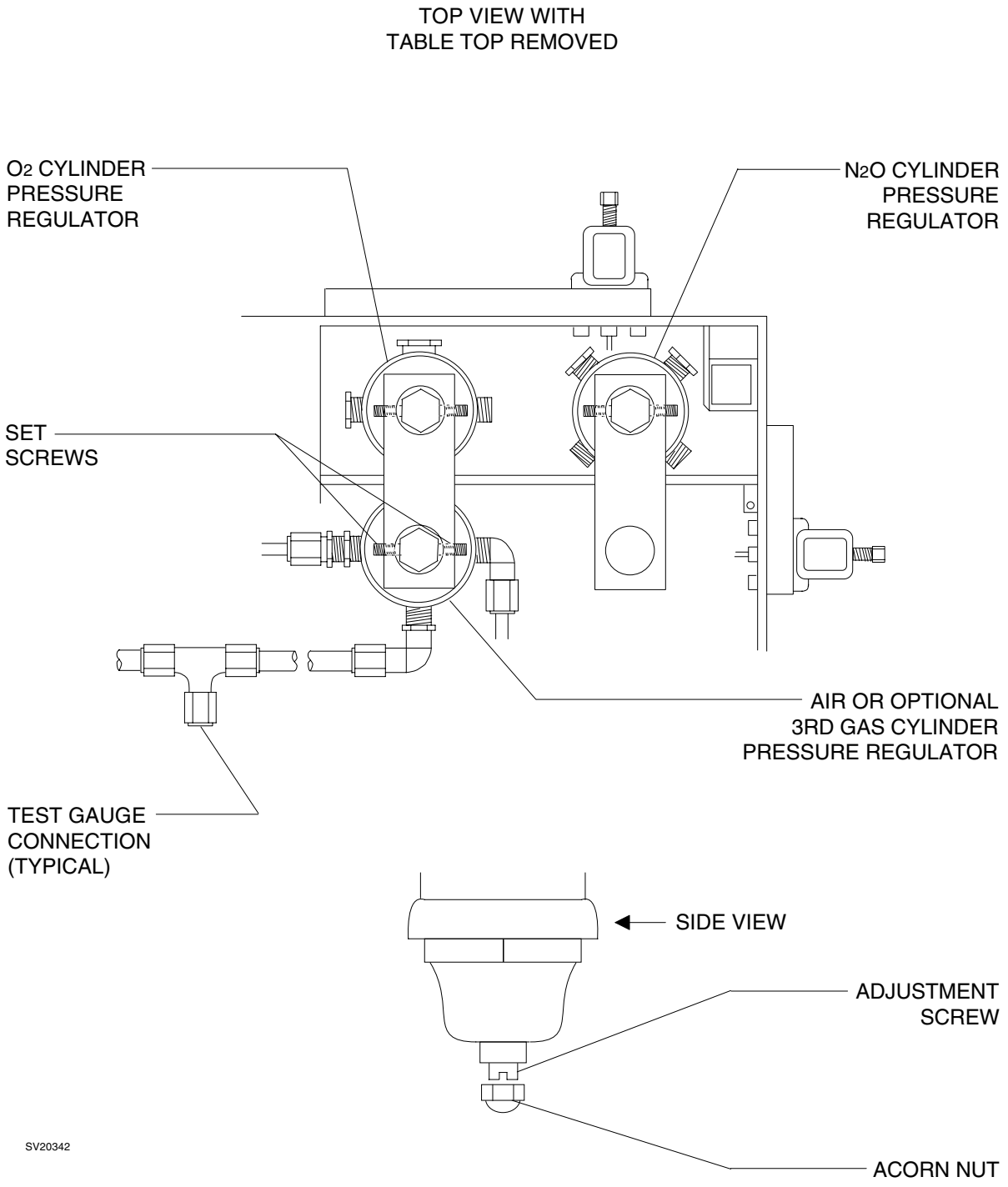



**Figure 5-1: CYLINDER PRESSURE REGULATOR ADJUSTMENT**

## 5.1A CO2 Cylinder Pressure Regulator Adjustment

5.1.1.A Perform Steps 5.1.1 thru 5.1.7.

5.1.2.A Open the $CO_2$ cylinder valve and set the System Power switch to ON.

5.1.3.A Fully open the $CO_2$ flow control valve.

5.1.4.A Remove the acorn nut on the bottom of the $CO_2$ regulator to expose the adjusting screw. Turn the screw until the $CO_2$ flowmeter indicates 550 ml/min.

5.1.5.A Replace the acorn nut on the bottom of the regulator.

5.1.6.A Close the cylinder valve and allow pressure to drain from the system.

5.1.7.A Close the flow control valve and set the System Power switch to STANDBY.

5.1.8.A Replace the table top and its retaining screws.

5.1.9.A Replace the top drawer in the cabinet.

5.1.10.A Connect the pipeline hoses.

5.1.11.A Perform the PMS Procedure given in Section 6.

## 5.2 Oxygen Supply Pressure Alarm Switch Adjustment (earlier machines)

5.2.1 Disconnect all pipeline hoses and set the System Power switch to ON.

5.2.2 Close all cylinder valves except the $O_2$ valve.

5.2.3 Set the oxygen flow to 5 liters per min.

5.2.4 Open the other gas flow control valves to drain pressure from the system.

5.2.5 Close the $O_2$ cylinder valve, and close the flow control valves. Press the $O_2$ Flush valve to drain oxygen pressure from the system.

5.2.6 Set the System Power switch to STANDBY.

5.2.7 Remove the flowmeter housing rear cover. Remove the table top and pull the writing or keyboard tray out to its fully extended position.

5.2.8 Locate the TEE fitting in the ¼ in. diameter $O_2$ regulator output line, and remove the plug from the TEE fitting.

5.2.9 Connect a dedicated $O_2$ test gauge to the TEE fitting.

5.2.10 Open the $O_2$ cylinder valve and set the System Power switch to ON.

5.2.11 Set the oxygen flow to 5 liters per min.

5.2.12 Close the oxygen cylinder valve.

5.2.13 As the pressure drops, the $O_2$ SUPPLY alarm should activate when the pressure is between 40 and 34 psi as shown on the test gauge.

5.2.14 If the alarm activates when the pressure is below 34 psi, turn the adjustment wheel to increase the setpoint (see illustration), repeat the test and adjust as necessary to bring the set point into the correct range.

If the alarm activates when the pressure is above 40 psi, turn the adjustment wheel to decrease the setpoint (see illustration), repeat the test and adjust as necessary to bring the set point into the correct range.

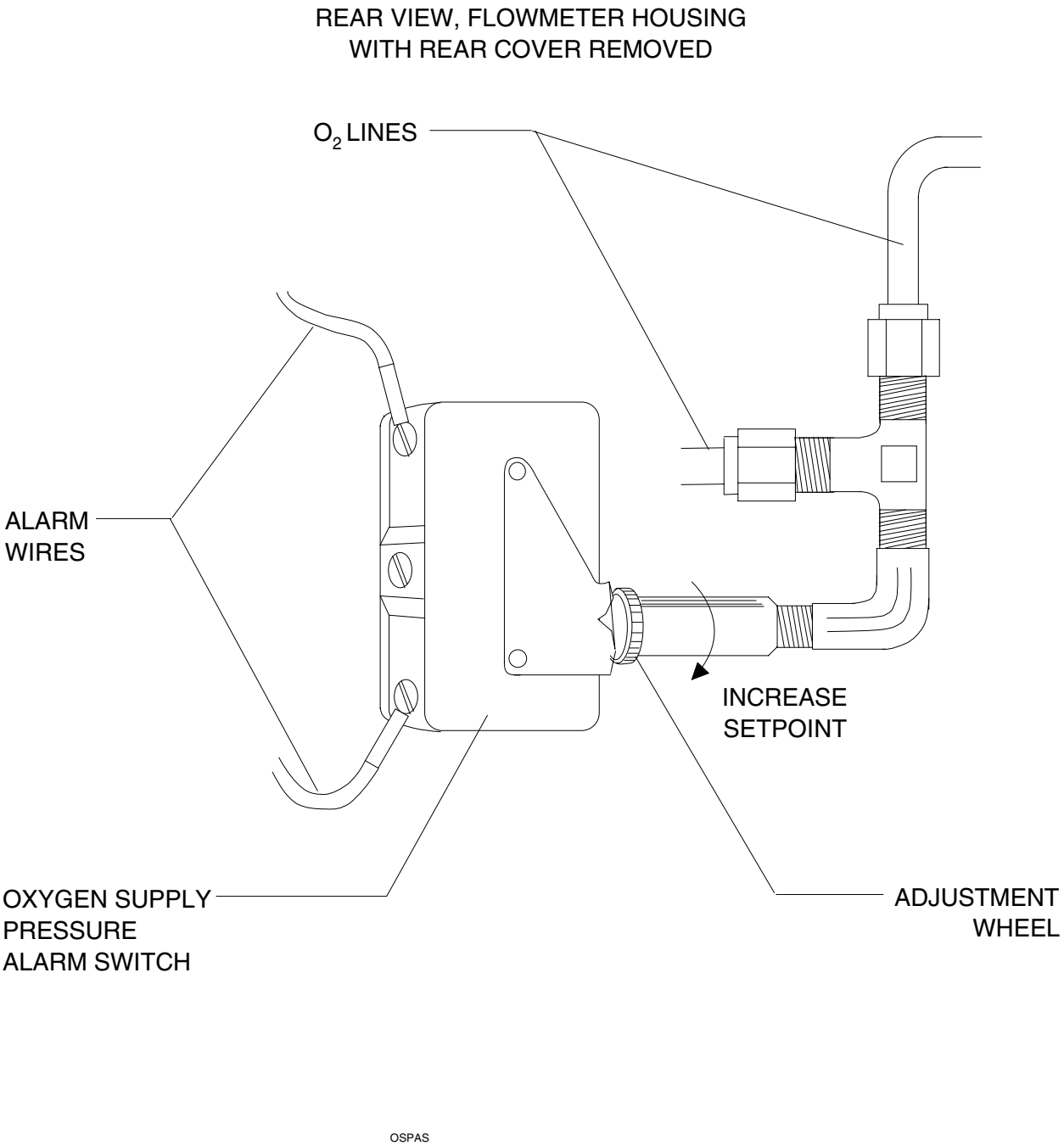



**Figure 5-2: $O_2$ ALARM SWITCH (earlier machines)**

5.2.15 Set the System Power switch to STANDBY.

5.2.16 Disconnect the test gauge and replace the plug in the regulator line TEE fitting.

5.2.17 Replace the table top and its retaining screws.

5.2.18 Replace the rear cover and its retaining screws.

5.2.19 Connect the pipeline hoses.

5.2.20 Perform the PMS Procedure given in Section 6.

## 5.3 Oxygen Supply Pressure Alarm Switch Adjustment (later machines with switch on alarm channel)

5.3.1 Disconnect all pipeline hoses and set the System Power switch to ON.

5.3.2 Close all cylinder valves except the $O_2$ valve.

5.3.3 Set the oxygen flow to 5 liters per min.

5.3.4 Open the other gas flow control valves to drain pressure from the system.

5.3.5 Close the $O_2$ cylinder valve, and close the flow control valves. Press the $O_2$ Flush valve to drain oxygen pressure from the system.

5.3.6 Set the System Power switch to STANDBY.

5.3.7 Remove the rear cover from the flowmeter housing. Remove the table top and pull the writing or keyboard tray out to its fully extended position.

5.3.8 Locate the TEE fitting in the ¼ in. diameter $O_2$ regulator output line, and remove the plug from the TEE fitting.

5.3.9 Connect a dedicated $O_2$ test gauge to the TEE fitting.

5.3.10 Open the $O_2$ cylinder valve and set the System Power switch to ON.

5.3.11 Set the oxygen flow to 5 liters per min.

5.2.12 Close the oxygen cylinder valve.

5.3.12 As the pressure drops, the $O_2$ SUPPLY alarm should activate when the pressure is between 40 and 34 psi as shown on the test gauge.

5.3.13 If the alarm activates when the pressure is below 34 psi or above 40 psi, turn the adjustment wheel (see illustration), repeat the test and adjust as necessary to bring the set point into the correct range.

5.3.14 Turn the System Power switch to STANDBY.

5.3.15 Disconnect the test gauge and replace the plug in the regulator line TEE fitting.

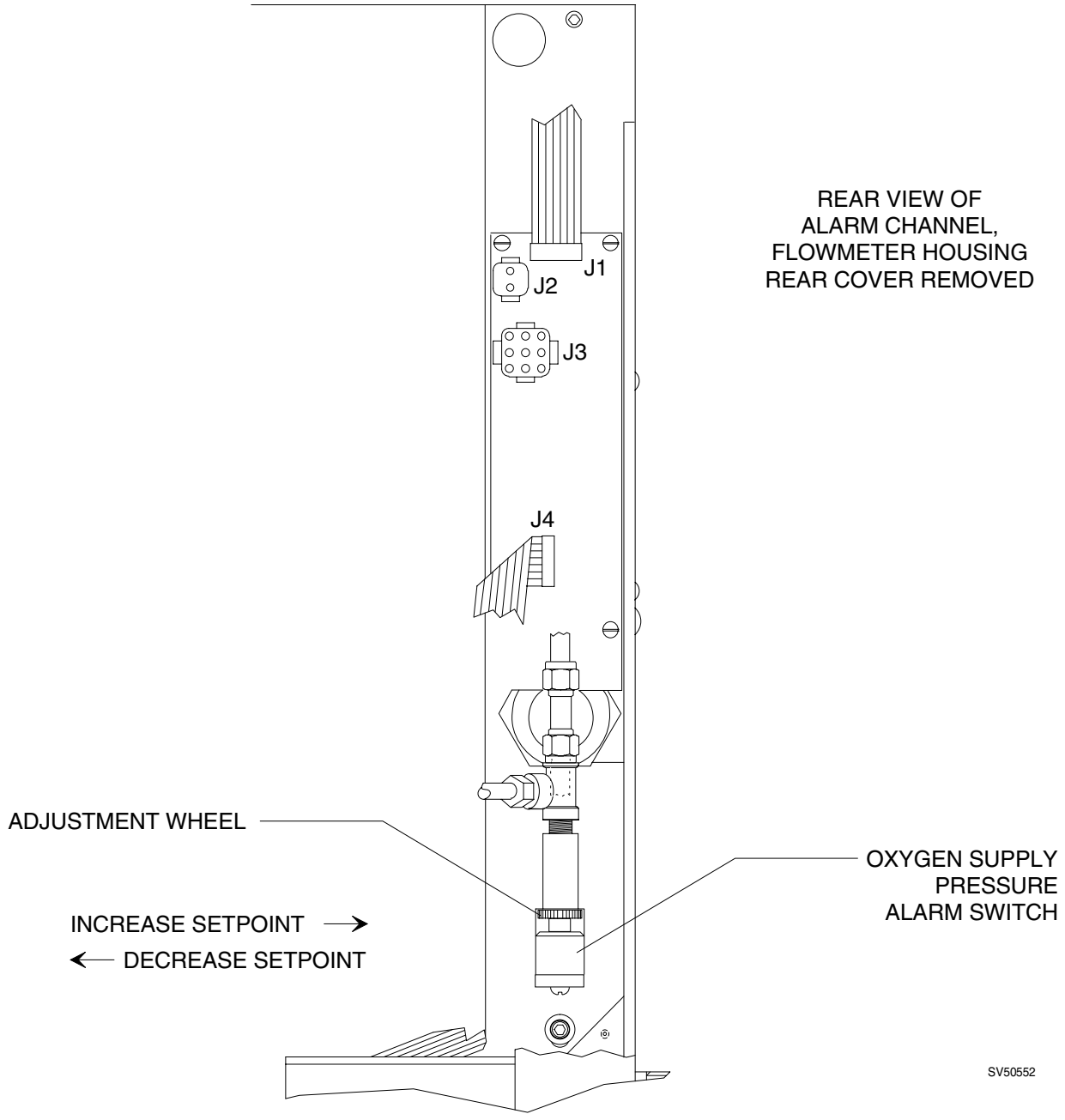



**Figure 5-3: OXYGEN SUPPLY PRESSURE ALARM SWITCH (later machines)**

5.3.16 Replace the table top and its retaining screws.

5.3.17 Replace the rear cover and its retaining screws.

5.3.18 Connect the pipeline hoses.

5.3.19 Perform the PMS Procedure given in Section 6.

## 5.4 Oxygen Ratio Monitor/Controller (ORMC) Adjustment

5.4.1 Remove the rear cover of the vapor box.

5.4.2 Connect a calibrated oxygen monitor to the Freshgas Outlet.

5.4.3 Disconnect the pipeline hoses.

5.4.4 Open the oxygen and nitrous oxide cylinder valves.

5.4.5 Set the System Power switch to ON.

5.4.6 Close the $O_2$ flow control valve.

5.4.7 Open the $N_2O$ flow control valve to its counter-clockwise stop.

5.4.8 If there is no nitrous oxide flow, proceed to Step 5.4.10.

5.4.9 If there is nitrous oxide flow, loosen setscrew E and move the cam mounting bracket to the right until the nitrous oxide flow stops. Tighten setscrew E.

5.4.10 Slowly open the $O_2$ flow control valve.

5.4.11 If the nitrous oxide starts to flow when the oxygen flow is between 200 and 300 ml per minute, proceed to Step 5.4.14.

5.4.12 If the nitrous oxide does not start to flow when the oxygen flow is between 200 and 300 ml per minute, loosen setscrew E and move the cam mounting bracket to the left until nitrous oxide flow starts. Tighten setscrew E.

5.4.13 Repeat steps 5.4.6 thru 5.4.12 until no further adjustment of the cam mounting bracket is needed.

5.4.14 Adjust the oxygen flow to a point where the nitrous oxide flowmeter indicates 10 liters per minute.

NOTE: Steps marked with an asterisk (*) do not apply to later model machines that do not have the $O_2/N_2O$ ratio lamp on the alarm channel.

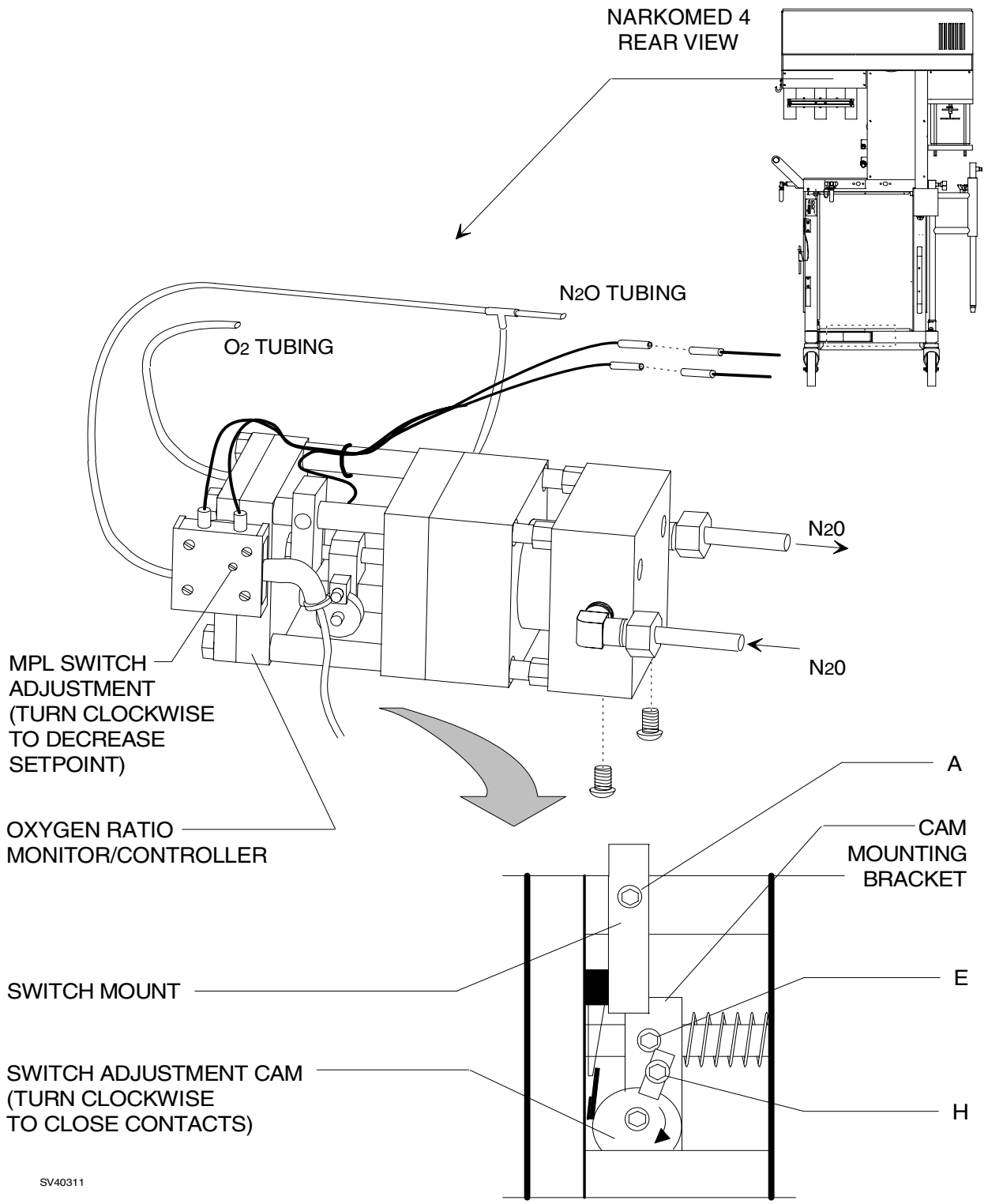



**Figure 5-4: OXYGEN RATIO MONITOR/CONTROLLER ADJUSTMENTS**

5.4.15 The oxygen concentration should be between 21% and 29% oxygen.

* 5.4.16 If the yellow $O_2/N_2O$ FLOW RATIO lamp on the alarm panel is lighted, proceed to step 5.4.20.

* 5.4.17 If the yellow $O_2/N_2O$ FLOW RATIO lamp on the alarm panel is not lighted, loosen setscrew H and turn the switch adjustment cam until it is pointing downward.

* 5.4.18 Loosen setscrew A and move the switch mount until it is nearly touching the switch adjustment cam. Tighten setscrew A.

* 5.4.19 Turn the switch adjustment cam clockwise until the contacts close and the $O_2/N_2O$ FLOW RATIO lamp is lighted. Tighten setscrew H.

* 5.4.20 Close the $N_2O$ flow control valve.

* 5.4.21 Adjust the oxygen flow to 1 liter per minute.

* 5.4.22 Slowly open the $N_2O$ flow control valve.

* 5.4.23 The yellow $O_2/N_2O$ FLOW RATIO lamp on the alarm panel should light as soon as the ORMC limits the flow of nitrous oxide.

* 5.4.24 Adjust the oxygen flow to 1.5 liters per minute.

* 5.4.25 Slowly open the $N_2O$ flow control valve.

* 5.4.26 The yellow $O_2/N_2O$ FLOW RATIO lamp on the alarm panel should light as soon as the ORMC limits the flow of nitrous oxide.

5.4.27 Adjust the oxygen flow to 2 liters per minute.

5.4.28 Slowly open the $N_2O$ flow control valve.

* 5.4.29 The yellow $O_2/N_2O$ FLOW RATIO lamp on the alarm panel should light as soon as the ORMC limits the flow of nitrous oxide.

5.4.30 Close the oxygen flow control valve. The nitrous oxide flow should decrease proportionally, and the oxygen concentration should remain between 21% and 29% oxygen.

5.4.31 The nitrous oxide flow should stop when the flow of oxygen is between 200 and 300 ml per minute.

* 5.4.32 If the $O_2/N_2O$ FLOW RATIO lamp turns off when the nitrous oxide flow drops to between 100 and 200 ml per minute, proceed to Step 5.4.34.

* 5.4.33 If the $O_2/N_2O$ FLOW RATIO lamp does not turn off when the nitrous oxide flow drops to between 100 and 200 ml per minute, adjust the MPL switch until the $O_2/N_2O$ FLOW RATIO lamp turns off.

5.4.34 Close the $N_2O$ flow control valve and set the System Power switch to STANDBY.

5.4.35 Replace the rear cover of the vapor box.

5.4.36 Perform the PMS Procedure given in Section 6.

## 5.5 Oxygen Ratio Controller (ORC) Adjustment

NOTE: See Procedure 5.5A for low flow ORC (P/N 4113229) adjustment.

5.5.1 Remove the rear cover of the flowmeter housing.

5.5.2 Connect a calibrated oxygen monitor to the fresh gas outlet.

5.5.3 Disconnect the pipeline hoses.

5.5.4 Open the oxygen and nitrous oxide cylinder valves.

5.5.5 Set the System Power switch to ON.

5.5.6 Close the $O_2$ and $N_2O$ flow control valves.

5.5.7 Set the $O_2$ flow control valve to 10 l/min.

5.5.8 Set the $N_2O$ flow control valve to 10 l/min.

5.5.9 Set the $O_2$ flow control valve to 800 ml/min for one (1) minute. Verify that the $O_2$ concentration indicates 21% to 29% $O_2$.

5.5.10 Decrease the oxygen flow rate.

5.5.11 If the nitrous oxide does not stop when the oxygen flow is between 325 and 350 ml per minute, loosen the adjusting screw locknut and turn the adjusting screw (counter-clockwise to decrease $N_2O$ flow, clockwise to increase $N_2O$ flow). Tighten the locknut.

5.5.12 Repeat steps 5.5.6 thru 5.5.11 until no further adjustment is needed.

5.5.13 Adjust the oxygen flow to a point where the nitrous oxide flowmeter indicates 10 liters per minute.

5.5.14 The oxygen concentration should be between 21% and 29% oxygen.

5.5.15 Slowly decrease the oxygen flow to 800 ml/min. The nitrous oxide flow should decrease proportionally, and the oxygen concentration should remain between 21% and 29% oxygen.

5.5.16 Reduce the $O_2$ flow to 500 ml/min. Verify that the $N_2O$ flow is greater than or equal to 600 ml/min.

REAR VIEW OF FLOWMETER HOUSING
WITH REAR COVER REMOVED

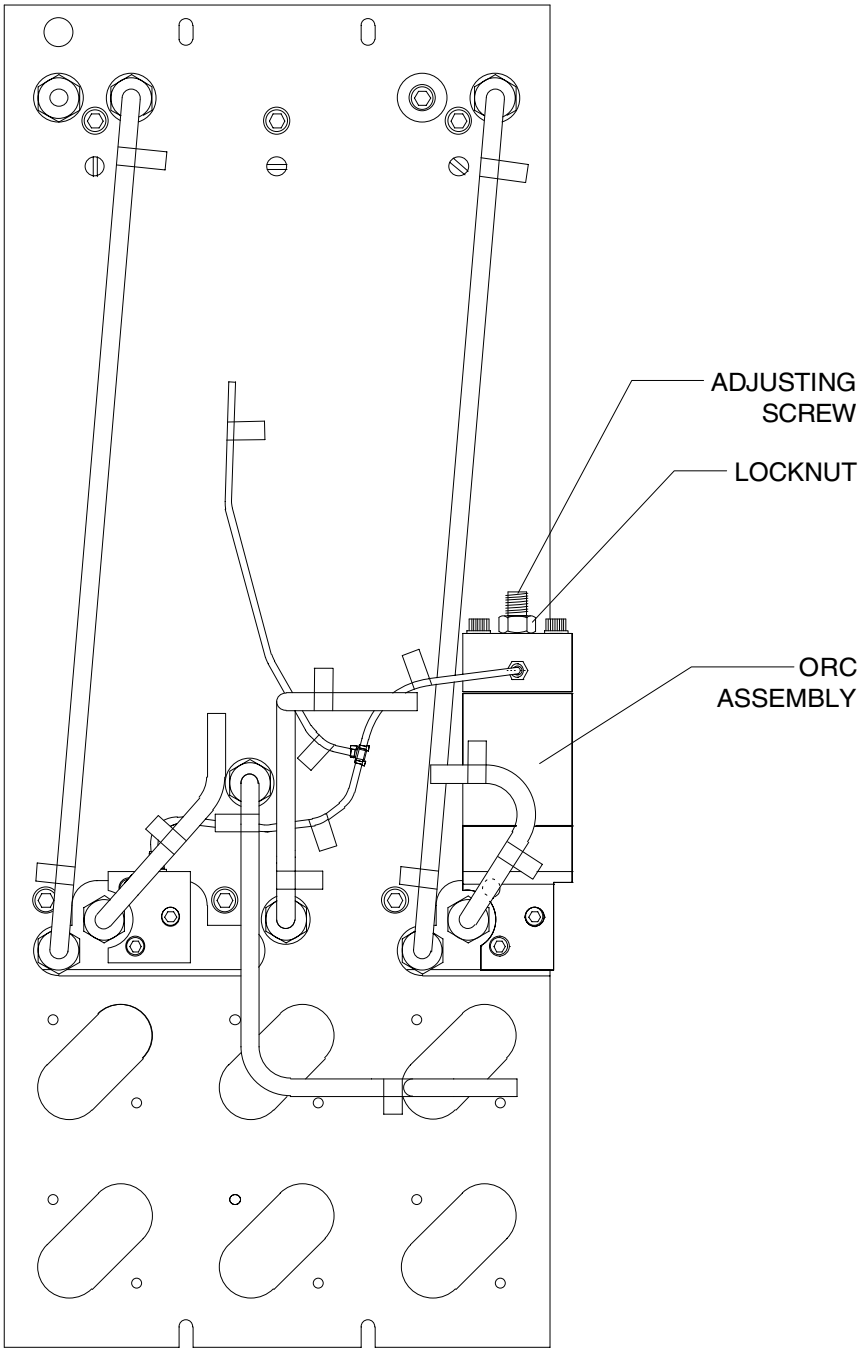



**Figure 5-5: OXYGEN RATIO CONTROLLER**

5.5.17 The nitrous oxide flow should stop when the flow of oxygen is between 250 and 400 ml per minute.

5.5.18 Close the $N_2O$ flow control valve and turn the System Power switch to STANDBY.

5.5.19 Reconnect the pipeline hoses.

5.5.20 Replace the flowmeter housing rear cover.

5.5.21 Perform the PMS Procedure given in Section 6.

## 5.5A Low Flow Oxygen Ratio Controller (ORC) Adjustment

5.5.1A Remove the rear cover of the flowmeter housing.

5.5.2A Connect a calibrated oxygen monitor to the fresh gas outlet.

5.5.3A Disconnect the pipeline hoses.

5.5.4A Pinch the $N_2O$ bypass line on the ORC. See Figure 5-5A.

5.5.5A Open the oxygen and nitrous oxide cylinder valves.

5.5.6A Set the System Power switch to ON.

5.5.7A Close the $O_2$ and $N_2O$ flow control valves.

5.5.8A Set the $O_2$ flow control valve to 10 l/min.

5.5.9A Set the $N_2O$ flow control valve to 10 l/min.

5.5.10A Set the $O_2$ flow control valve to 800 ml/min for one (1) minute. Verify that the $O_2$ concentration indicates 21% to 29% $O_2$.

5.5.11A Decrease the oxygen flow rate.

5.5.12A If the nitrous oxide flow does not stop when the oxygen flow rate is between 325 and 350 ml per minute, loosen the adjusting screw locknut and turn the adjusting screw (counter-clockwise to decrease $N_2O$ flow, clockwise to increase $N_2O$ flow). Tighten the locknut.

5.5.13A Repeat steps 5.5.7A thru 5.5.12A until no further adjustment is needed.

5.5.14A Adjust the oxygen flow to a point where the nitrous oxide flowmeter indicates 10 liters per minute.

5.5.15A The oxygen concentration should be between 21% and 29% oxygen.

5.5.16A Slowly decrease the oxygen flow to 800 ml/min. The nitrous oxide flow should decrease proportionally, and the oxygen concentration should remain between 21% and 29% oxygen.

5.5.17A Reduce the $O_2$ flow to 500 ml/min. Verify that the $N_2O$ flow is greater than or equal to 600 ml/min.

5.5.18A The nitrous oxide flow should stop when the flow of oxygen is between 250 and 400 ml per minute.

5.5.19A Un-pinch the $N_2O$ bypass line on the ORC.

5.5.20A Close the $O_2$ flow control valve, and fully open the $N_2O$ flow control valve. Verify that the $O_2$ concentration is 22 - 31%.

5.5.21A Close the $N_2O$ flow control valve and turn the System Power switch to STANDBY.

5.5.22A Reconnect the pipeline hoses.

5.5.23A Replace the flowmeter housing rear cover.

5.5.24A Perform the PMS Procedure given in Section 6.

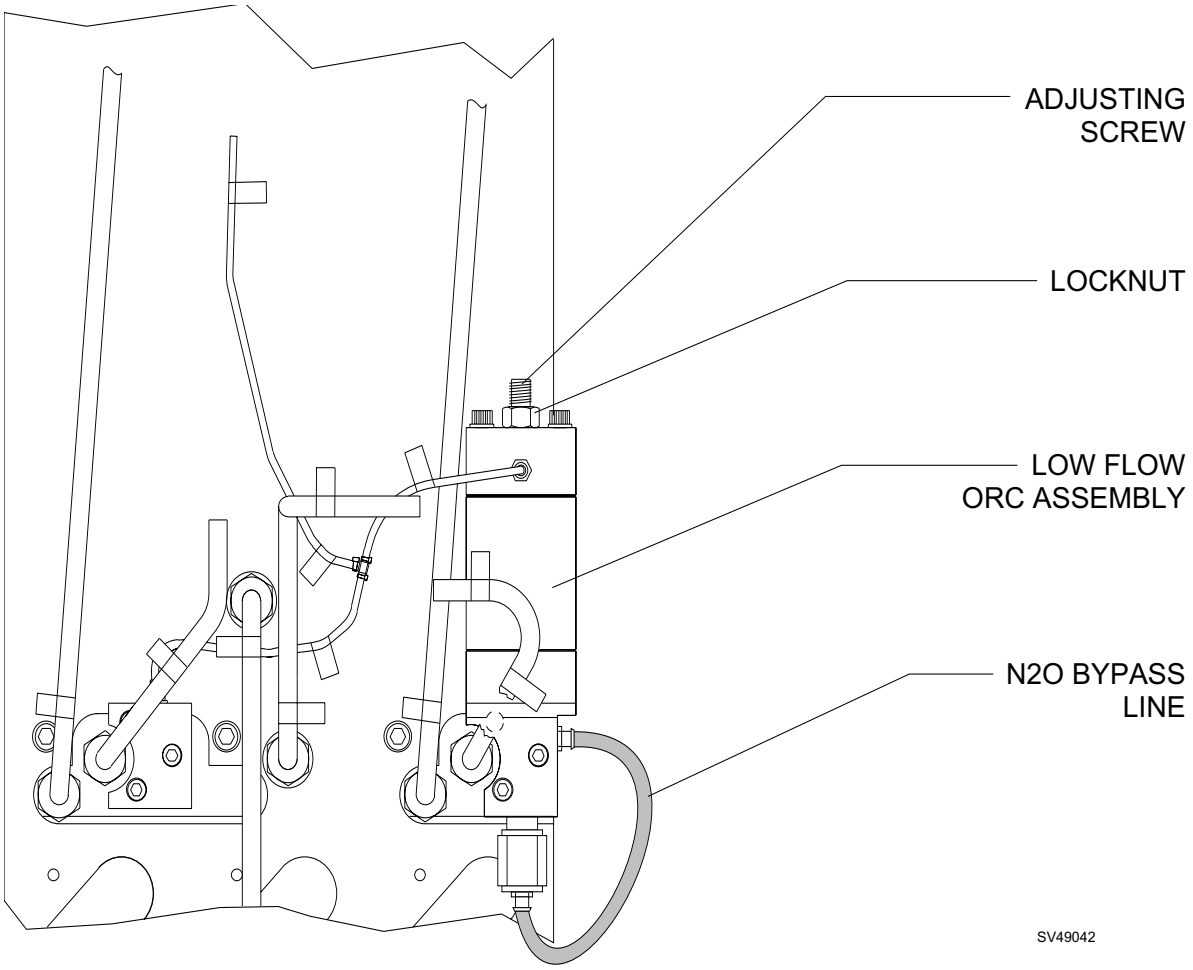



**Figure 5-5A: LOW FLOW OXYGEN RATIO CONTROLLER**

## 5.6 Boom Arm Tension Adjustments

5.6.1 Boom Arm Mounting Hinge Adjustment:

5.6.1.1 If the anesthesia equipment has an optional manual sphygmomanometer gauge, disconnect its tubing and remove the gauge by unscrewing its retaining ring. If the anesthesia equipment does not have a manual sphygmomanometer gauge, remove the cap covering the threads of the gauge mount.

5.6.1.2 Loosen the locking setscrew in the boom arm mounting block.

5.6.1.3 Tighten the boom arm mounting screw to a torque of 190 to 210 inch pounds, then tighten the locking setscrew.

5.6.1.4 Replace the cap covering the gauge mount threads, or replace the manual sphygmomanometer gauge if the unit is so equipped.

5.6.2 Boom Arm Center Hinge Adjustment:

5.6.2.1 Remove the upper and lower plastic caps to expose the recessed hinge screws and nuts.

5.6.2.2 While holding each nut from the bottom with a socket wrench, tighten the center hinge screw to a torque of 70 to 80 inch pounds, and the hinge mounting screw to a torque of 85 to 95 inch pounds.

5.6.2.3 Replace the upper and lower plastic caps.

5.6.3 Remote Display Torque Adjustment:

5.6.3.1 Remove the plastic cap at the end of the boom arm to expose the remote display assembly mounting screw.

5.6.3.2 While holding the remote display assembly, tighten the mounting screw to a torque of 3 to 5 foot pounds.

5.6.3.3 Replace the plastic cap at the end of the boom arm.

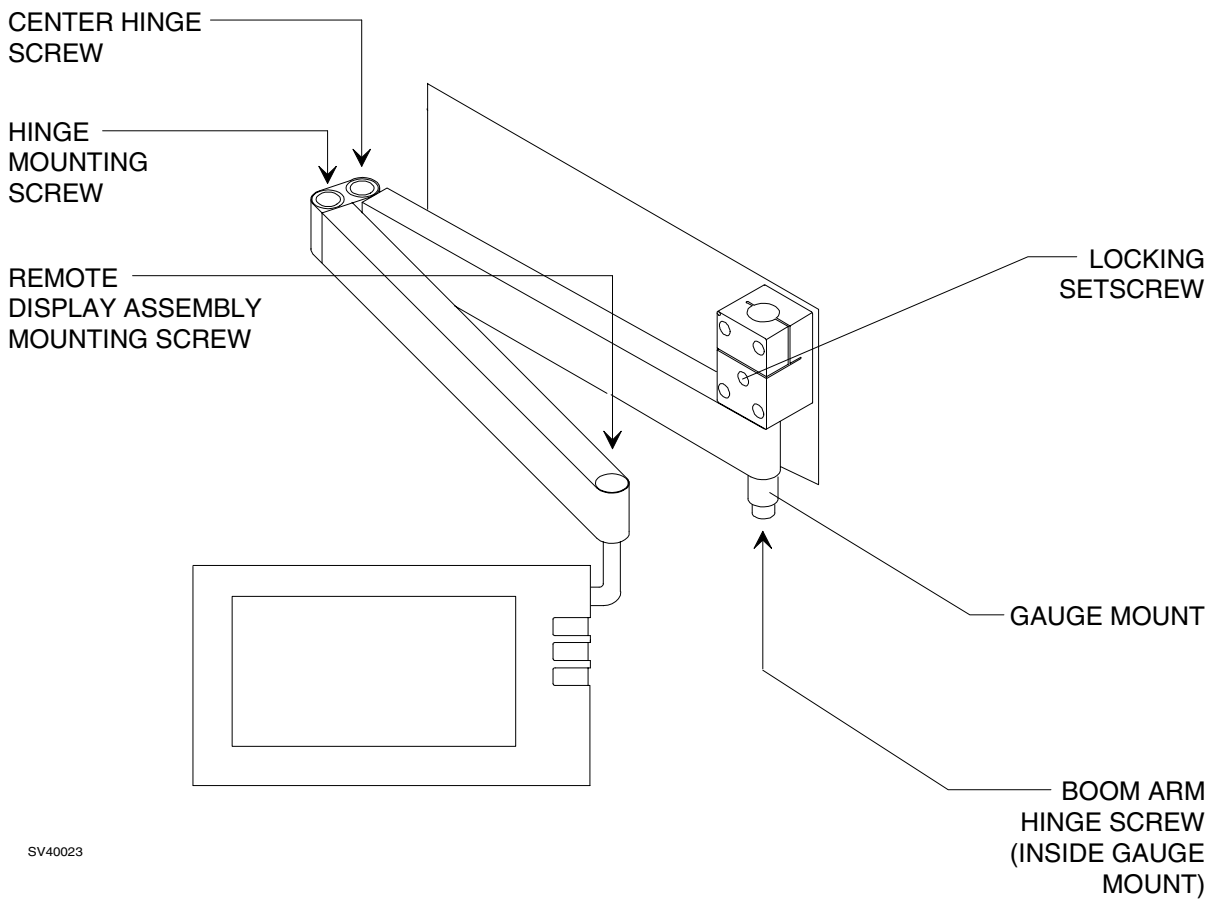



**Figure 5-6: BOOM ARM TENSION ADJUSTMENTS**

## 5.7 Display Arm Tension Adjustments

### 5.7.1 Display Arm Hinge Adjustment:

5.7.1.1 Loosen the friction adjustment screw on the underside of the display arm (no more than one turn). (It may be necessary to raise or lower the arm to align the screw with the access hole.) See Figure 5-7.

5.7.1.2 Raise and release the arm, and verify that it returns to an approximately horizontal position.

Lower and release tha arm, and verify that it returns to an approximately horizontal position.

Contact the NAD Service Department if the display arm fails to return to a near-horizontal position.

5.7.1.3 With the arm in a horizontal position, slowly re-tighten the friction adjustment screw until the arm stays in position when raised or lowered. (Do not over-tighten the screw as this will cause the arm to loose tension in the raised position.)

### 5.7.2 Machine Mount Joint:

5.7.2.1 If there is excessive free swing at the machine mount joint, tighten the shoulder screw shown in the illustration. The correct torque setting is 75 in. lbs.

### 5.7.3 Datagrip and Remote Display Assembly Torque Adjustment:

5.7.3.1 Remove the plastic cap at the end of the display arm to expose the remote display assembly mounting screw.

5.7.3.2 While holding the remote display assembly, tighten the mounting screw to a torque of 3 to 5 foot pounds.

5.7.3.3 Replace the plastic cap at the end of the display arm.

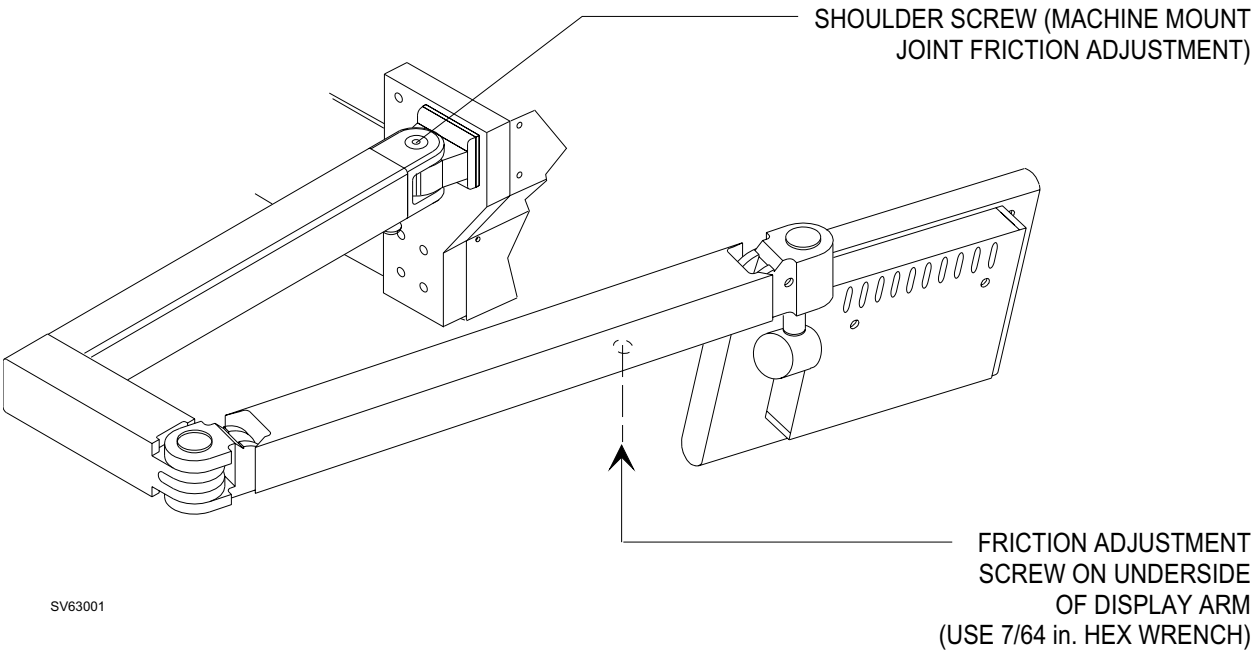

SHOULDER SCREW (MACHINE MOUNT JOINT FRICTION ADJUSTMENT)
FRICTION ADJUSTMENT SCREW ON UNDERSIDE OF DISPLAY ARM (USE 7/64 in. HEX WRENCH)
SV63001

**Figure 5-7: DISPLAY ARM ADJUSTMENTS**

## 5.8 Oxygen Sensor Zero Calibration

5.8.1 Remove the oxygen sensor assembly from the inspiratory valve dome.

5.8.2 Set the System Power switch to ON.

5.8.3 Enter the main service screen by simultaneously pressing the MONITOR key, SYSTEM CONFIG key, and the Selection DIAL.

5.8.4 Touch the MONITORS key on the screen to bring up the second column of touch keys.

5.8.5 Touch the OXYGEN key on the screen.

5.8.6 Remove the sensor capsule from its housing.

5.8.7 Allow time for the displayed oxygen cell values to stabilize.

5.8.8 Touch the STORE ZERO key on the screen.

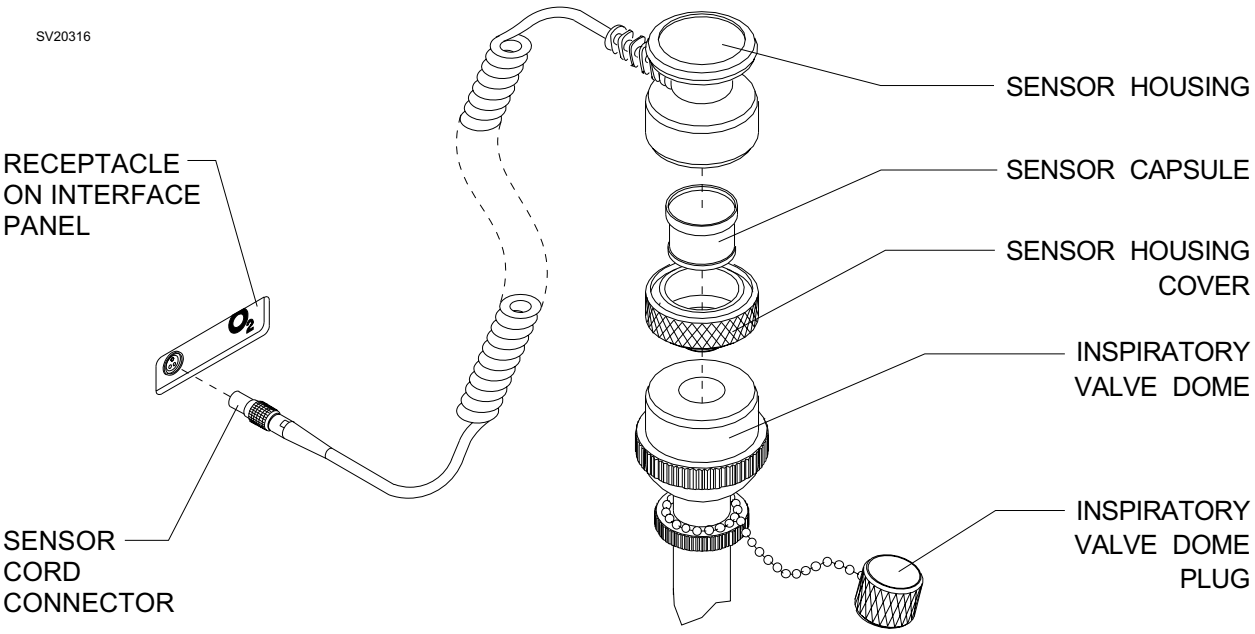
5.8.9 Disconnect the sensor cable from the interface panel.

5.8.10 Replace the sensor capsule in its housing.

5.8.11 Install the oxygen sensor assembly in the inspiratory valve dome.

5.8.12 Reconnect the sensor cable to the interface panel.

5.8.13 Turn the System Power switch to STANDBY, then return it to the ON position to retain the new value.



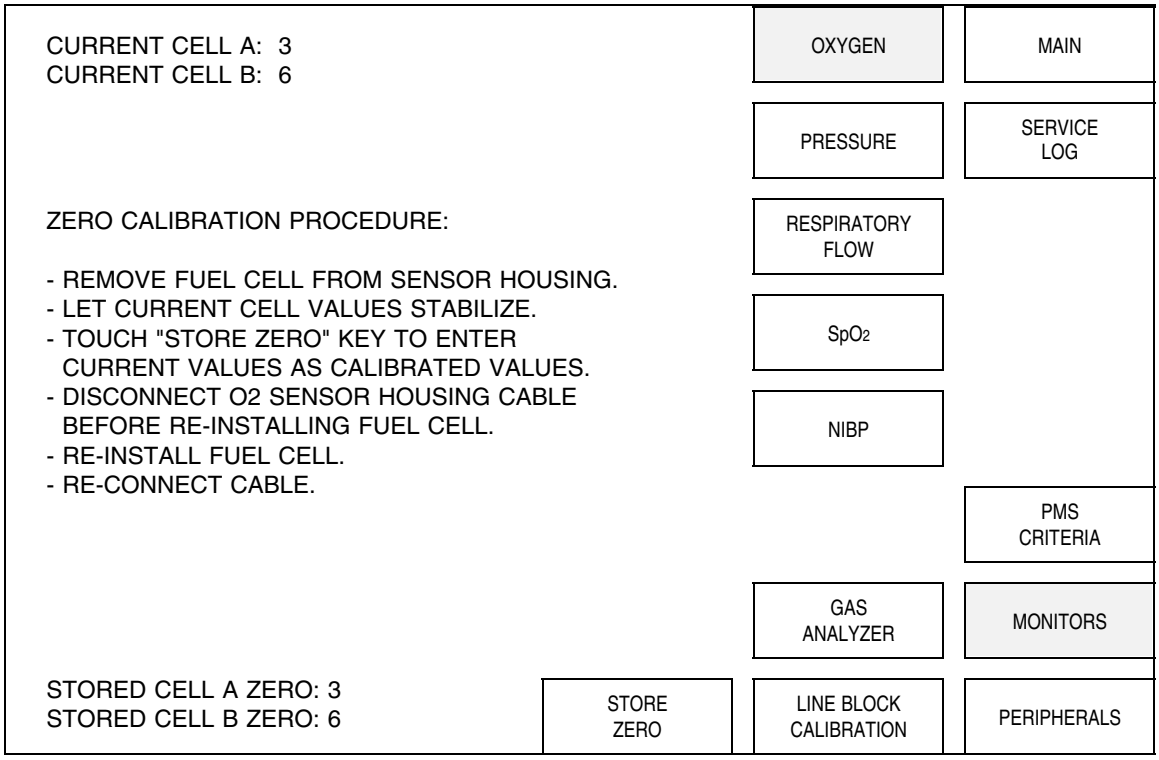




**Figure 5-8: OXYGEN SENSOR CONNECTIONS AND CALIBRATION SCREEN SCREEN**

## 5.9 Breathing Pressure Monitor Calibration

5.9.1 Set the System Power switch to ON.

5.9.2 Enter the main service screen by simultaneously pressing the MONITOR key, SYSTEM CONFIG key, and the Selection DIAL.

5.9.3 Touch the MONITORS key on the screen to bring up the second column of touch keys.

5.9.4 Touch the PRESSURE key on the screen.

5.9.5 Disconnect the breathing pressure sample line from the absorber.

5.9.6 Allow the current pressure value displayed to stabilize, and touch the STORE ZERO key on the screen.

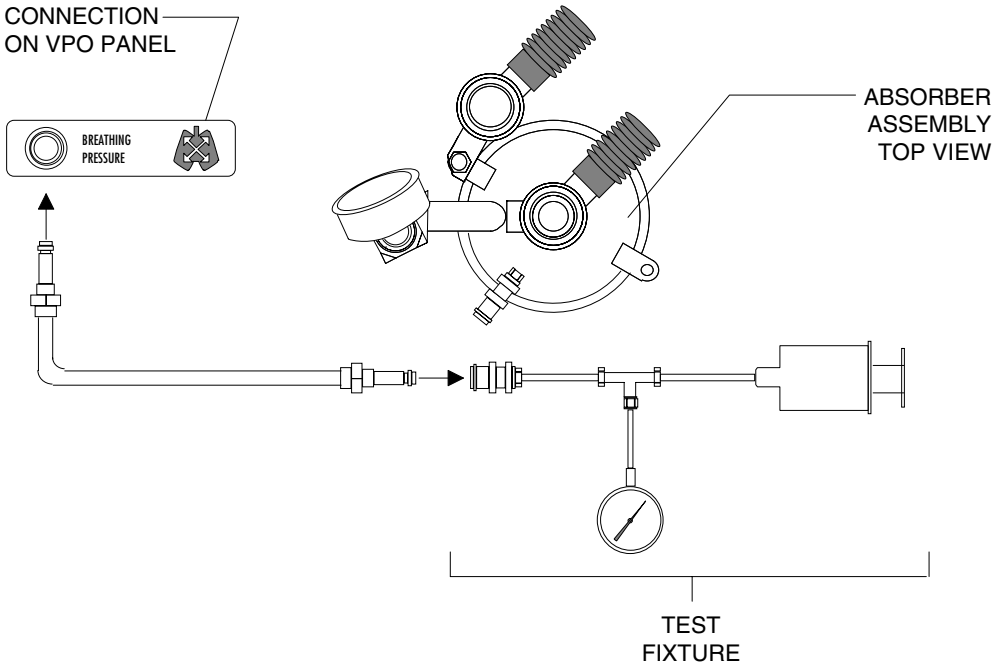
5.9.7 Connect a test fixture having a TEE connector, an external gauge, and an inflation device, to the breathing pressure line.

5.9.8 Pressurize the line to 50 cm $H_2O$ as shown on the external gauge.

5.9.9 Allow the current pressure value displayed to stabilize, and touch the STORE SPAN key on the screen.

5.9.10 Remove the test fixture from the from the breathing pressure sample line, and connect the line to the absorber.

5.9.11 Turn the System Power switch to STANDBY, then return it to the ON position to retain the new values.



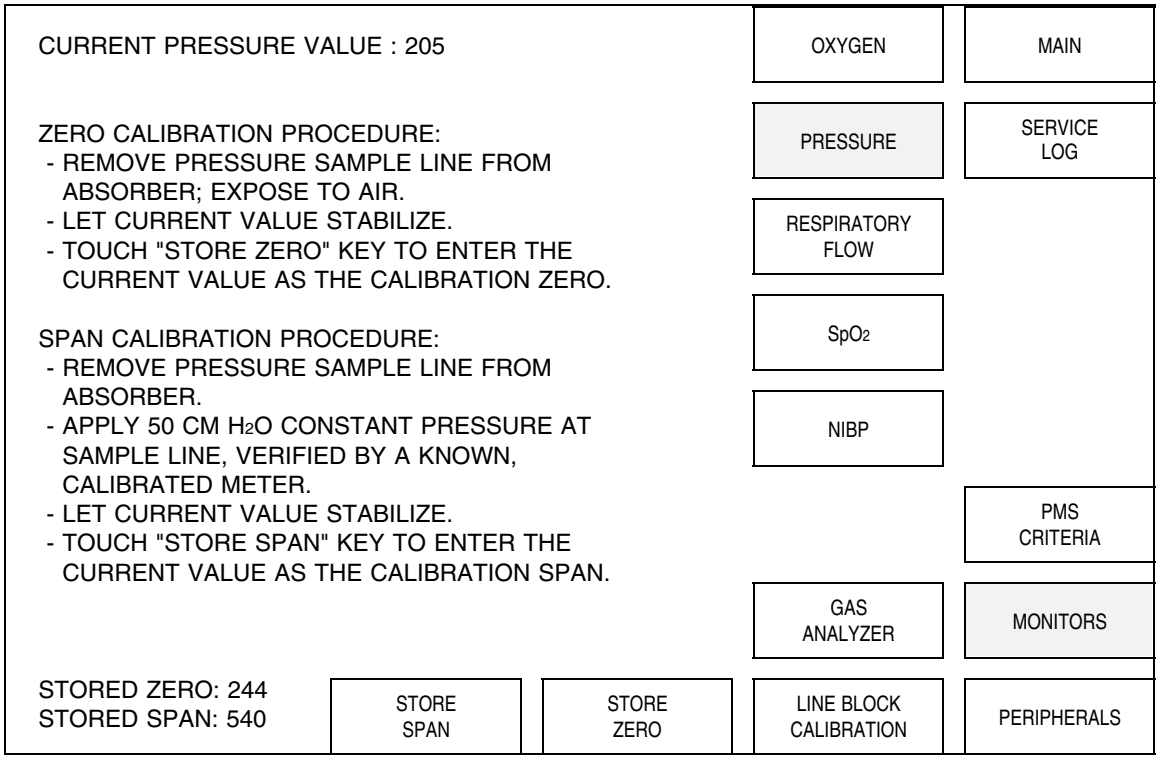


CURRENT PRESSURE VALUE : 205
ZERO CALIBRATION PROCEDURE:
- REMOVE PRESSURE SAMPLE LINE FROM ABSORBER; EXPOSE TO AIR.
- LET CURRENT VALUE STABILIZE.
- TOUCH "STORE ZERO" KEY TO ENTER THE CURRENT VALUE AS THE CALIBRATION ZERO.
SPAN CALIBRATION PROCEDURE:
- REMOVE PRESSURE SAMPLE LINE FROM ABSORBER.
- APPLY 50 CM H2O CONSTANT PRESSURE AT SAMPLE LINE, VERIFIED BY A KNOWN, CALIBRATED METER.
- LET CURRENT VALUE STABILIZE.
- TOUCH "STORE SPAN" KEY TO ENTER THE CURRENT VALUE AS THE CALIBRATION SPAN.
STORED ZERO: 244
STORED SPAN: 540
OXYGEN
MAIN
PRESSURE
SERVICE LOG
RESPIRATORY FLOW
SpO2
NIBP
PMS CRITERIA
GAS ANALYZER
MONITORS
STORE SPAN
STORE ZERO
LINE BLOCK CALIBRATION
PERIPHERALS

**Figure 5-9: BREATHING PRESSURE MONITOR CALIBRATION SETUP AND SCREEN**

## * 5.10 Respiratory Flow Monitor Calibration

5.10.1 Set the System Power switch to ON.

5.10.2 Enter the main service screen by simultaneously pressing the MONITOR key, SYSTEM CONFIG key, and the Selection DIAL.

5.10.3 Touch the MONITORS key on the screen to bring up the second column of touch keys.

5.10.4 Touch the RESP FLOW key on the screen.

5.10.5 Remove the 22 mm hose connected to the expiratory valve, and remove the Spiromed sensor from the absorber.

5.10.6 Allow the current flow value displayed to stabilize, and touch the STORE ZERO key on the screen.

5.10.7 Disconnect the absorber freshgas hose from the freshgas outlet of the machine.

5.10.8 Connect a test hose from the freshgas outlet to the 22 mm connector on the expiratory valve.

5.10.9 Open the oxygen cylinder valve, and adjust the $O_2$ flow control valve to achieve a flow rate of 10 liters per minute.

5.10.10 Allow the current flow value displayed to stabilize, and touch the STORE SPAN key on the screen.

5.10.11 Close the $O_2$ flow control valve, and close the oxygen cylinder valve.

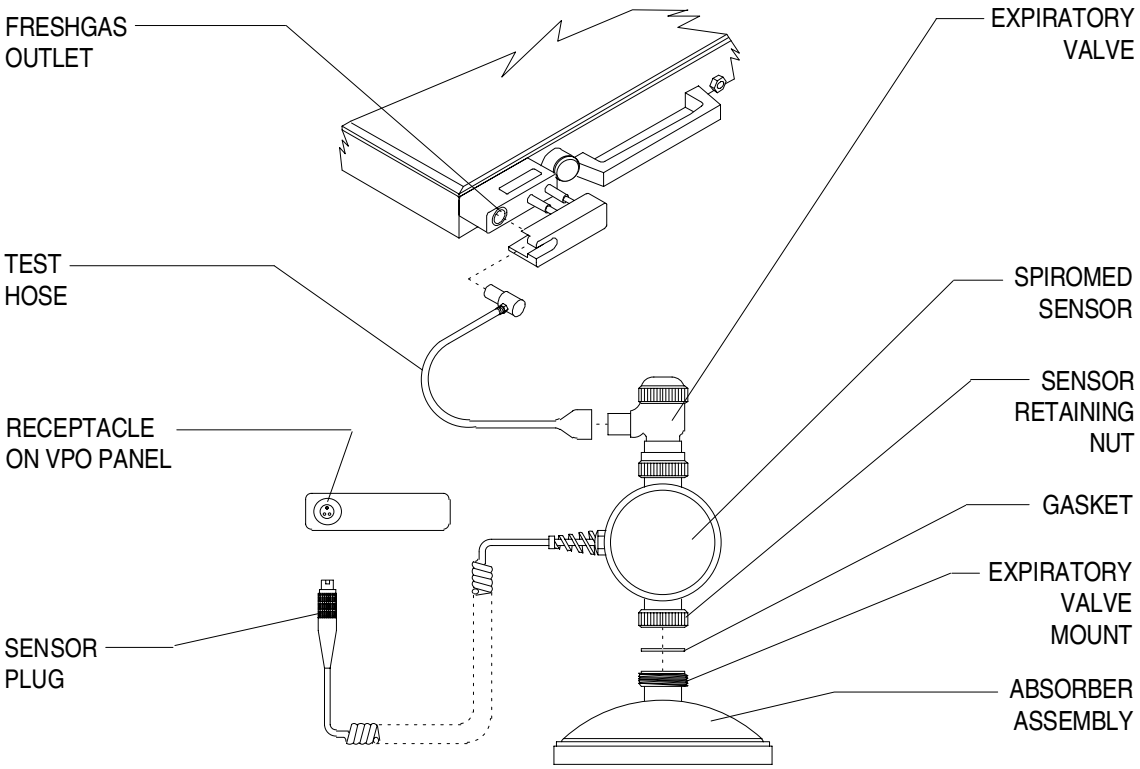
5.10.12 Disconnect the test hose and connect the absorber freshgas hose to the freshgas outlet.

5.10.13 Place the Spiromed sensor on the absorber and tighten the sensor retaining nut. Ensure that the gasket is seated properly.

5.10.14 Turn the System Power switch to STANDBY, then return it to the ON position to retain the new values.

5.10.15 Reconnect the 22 mm hose to the expiratory valve.

* This procedure does not apply to units equipped with ultrasonic flow sensor.



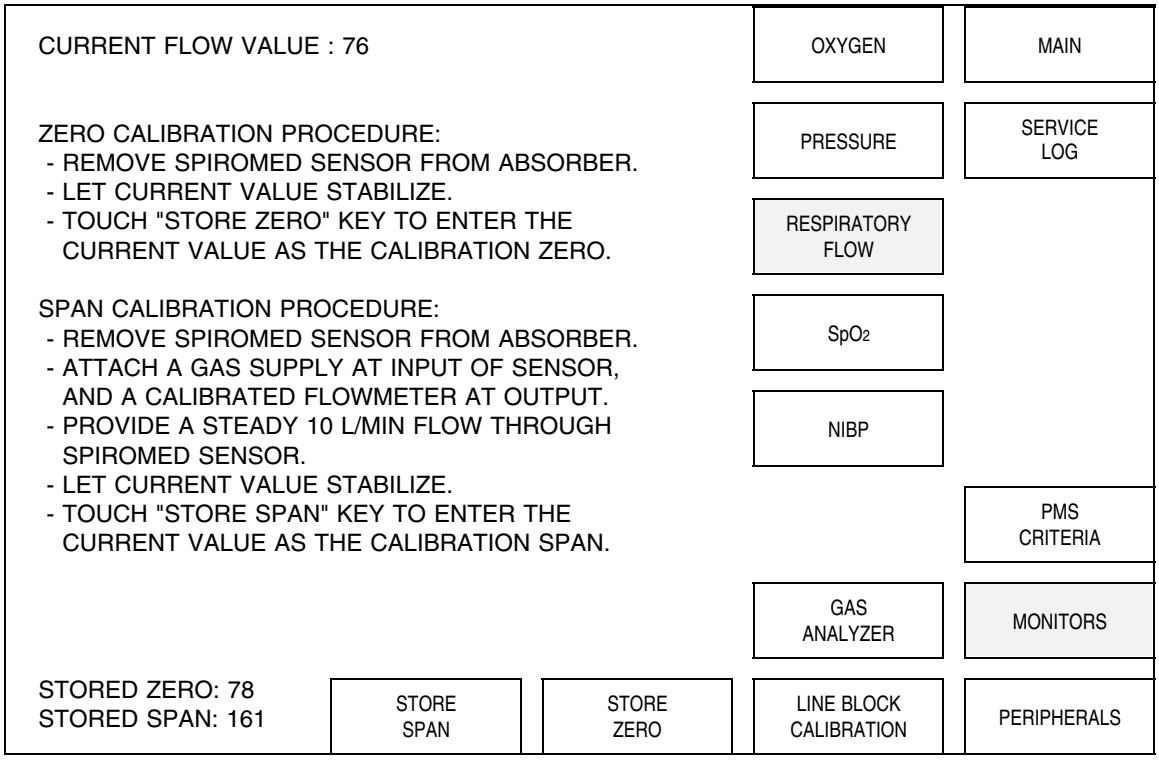


CURRENT FLOW VALUE : 76
ZERO CALIBRATION PROCEDURE:
- REMOVE SPIROMED SENSOR FROM ABSORBER.
- LET CURRENT VALUE STABILIZE.
- TOUCH "STORE ZERO" KEY TO ENTER THE CURRENT VALUE AS THE CALIBRATION ZERO.
SPAN CALIBRATION PROCEDURE:
- REMOVE SPIROMED SENSOR FROM ABSORBER.
- ATTACH A GAS SUPPLY AT INPUT OF SENSOR, AND A CALIBRATED FLOWMETER AT OUTPUT.
- PROVIDE A STEADY 10 L/MIN FLOW THROUGH SPIROMED SENSOR.
- LET CURRENT VALUE STABILIZE.
- TOUCH "STORE SPAN" KEY TO ENTER THE CURRENT VALUE AS THE CALIBRATION SPAN.
STORED ZERO: 78
STORED SPAN: 161
STORE SPAN
STORE ZERO
OXYGEN
PRESSURE
RESPIRATORY FLOW
SpO2
NIBP
GAS ANALYZER
LINE BLOCK CALIBRATION
MAIN
SERVICE LOG
PMS CRITERIA
MONITORS
PERIPHERALS

**Figure 5-10: RESPIRATORY VOLUME MONITOR CALIBRATION SETUP AND SCREEN**

## 5.11 SpO2 Monitor Calibration Check - Nellcor®

5.11.1 Set the system Power switch to STANDBY.

5.11.2 Disconnect the $SpO_2$ sensor cable from the Nellcor module, and plug the Nellcor model PT-2500 Pocket Tester into the module.

5.11.3 Set the System Power switch to ON.

5.11.4 Enter the main service screen by simultaneously pressing the MONITOR key, SYSTEM CONFIG key, and the Selection DIAL.

5.11.5 Touch the MONITORS key on the screen to bring up the second column of touch keys.

5.11.6 Touch the $SpO_2$ key on the screen.

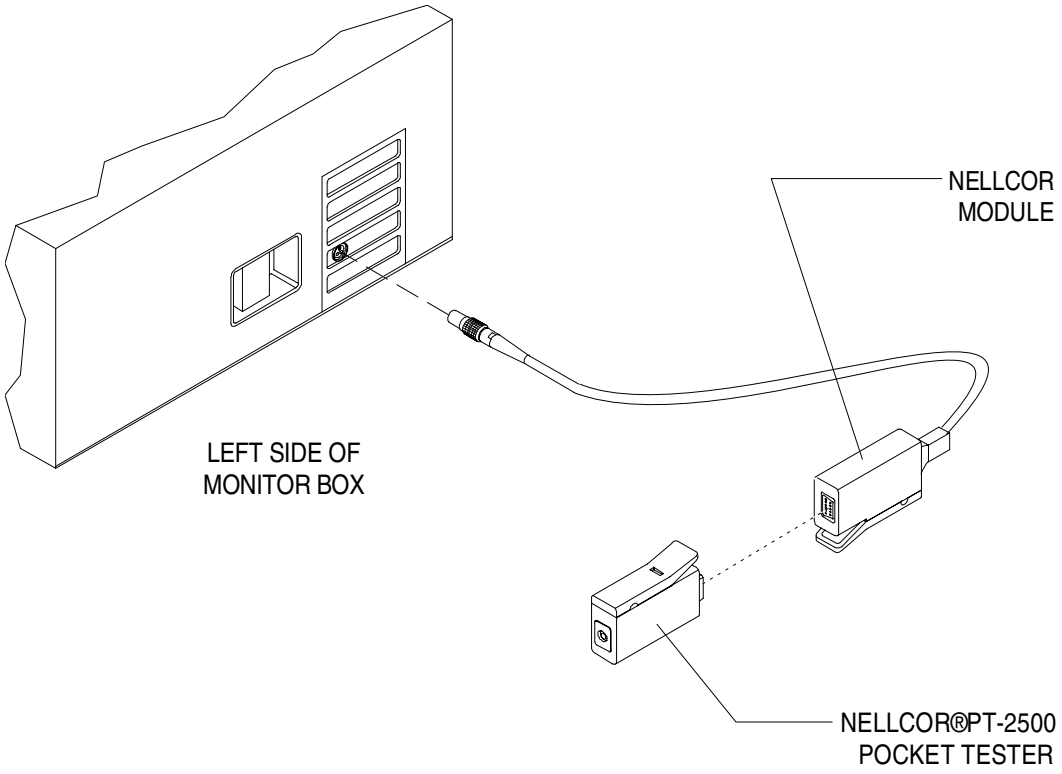
5.11.7 The red indicator lamp on the PT-2500 should be lighted, indicating that the tester is working properly.

5.11.8 The screen should display an $SpO_2$ value of 81 ± 1, and a Pulse value of 61 ± 1 if the machine is equipped with a Nellcor MP-202 pulse oximeter module.

If the machine is equipped with a Nellcor MP-203 pulse oximeter, the Pulse value displayed should be 40 ± 1.

5.11.9 Set the System Power switch to STANDBY.

5.11.10 Disconnect the PT-2500 from the Nellcor module, and connect the $SpO_2$ sensor cable to the module.



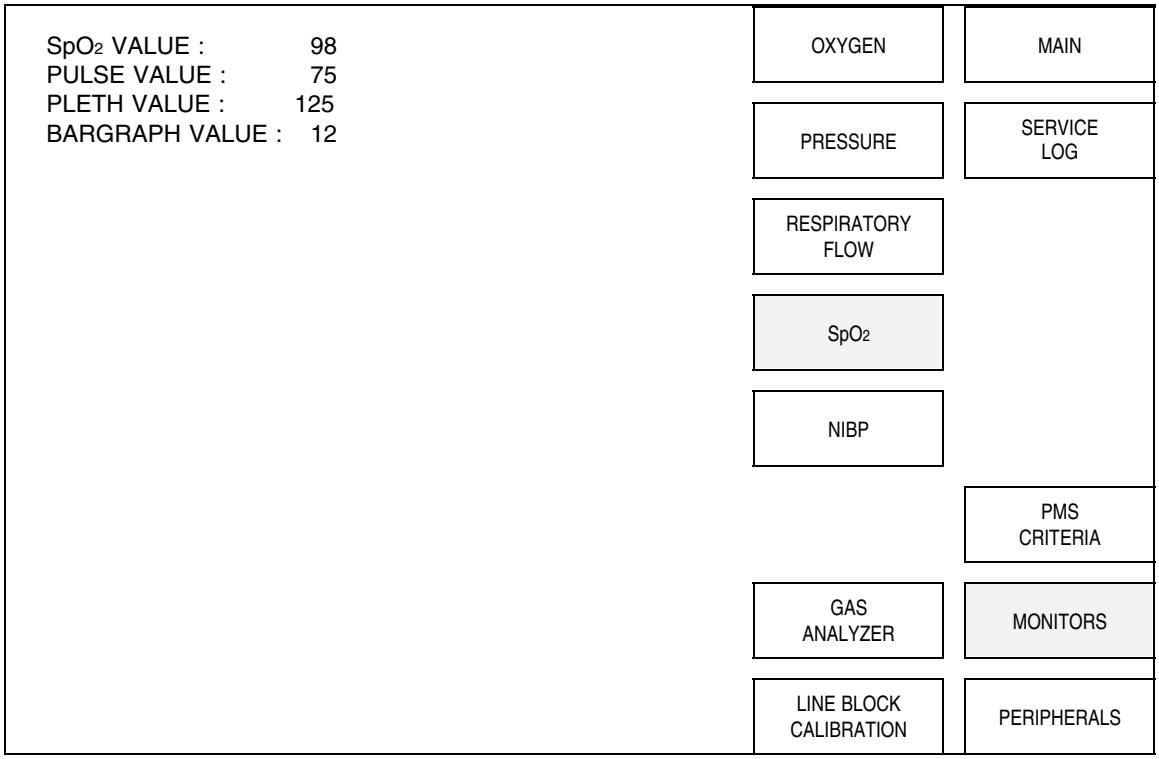




**Figure 5-11: $SpO_2$ CALIBRATION CONNECTIONS AND SCREEN (NELLCOR)**

## 5.11A SpO2 Monitor Calibration Check - Novametrix

5.11A.1 Plug the SpO2 sensor extension cable into the machine interface.

5.11A.2 Disconnect the finger probe from the extension cable and attach a Novametrix TB500B sensor simulator to the extension cable.

5.11A.3 Turn the System Power switch to ON. press and hold the Selection Dial, and simultaneously press the MONITOR and SYSTEM CONFIG keys to enter the main service screen. Touch the MONITORS key to bring up a second column of touch keys.

5.11A.4 Touch the SpO2 key on the screen.

5.11A.5 Set the simulator's Sensor Type switch to 87XX. Set the output signal to 3 and the saturation to 82%. Turn the simulator ON and verify that the monitor's displayed Pulse reading is 60 ±1 BPM and the SaO2 reading is 82 ±2.

NOTE: Do not rely on the simulator's low battery LED as an indicator of sufficient battery power. Replace the battery with a fresh 9 volt transistor battery if proper measured values are not obtained and the battery measures ≤8.5 VDC.

5.11A.6 Adjust the simulator's saturation setting to 100 and verify that the monitor indicates 99 ±1. Adjust the saturation to 62 and verify that the monitor indicates 62 ±2.

5.11A.7 Depress the Open Test RED key and verify that the PULSE LO LED activates, a continuous audible alarm is heard, and a NO OXI PULSE warning alarm is shown on the central alarm display. Release the test key. Depress the Open Test INFRARED key and verify the same alarm results occur as in the previous test.

5.11A.8 Depress both Open Test keys together and verify that the monitors SaO2 and OXI ALARMS DISABLE indicators activate, a single audible tone is heard, and OXI SEN DISC advisory alarm is shown on the central alarm display. Release the Open Test keys.

5.11A.9 Disconnect the simulator and re-connect the finger probe. Attach the sensor to the operator's finger and obtain pulse, and oxygen saturation readings. Disconnect the sensor from the finger. Afther ten (10) seconds, the Warning message NO OXI PULSE shall appear on the central alarm display and a continuous audible alarm shall sound.

5.11A.10 Return the monitor to Standby.

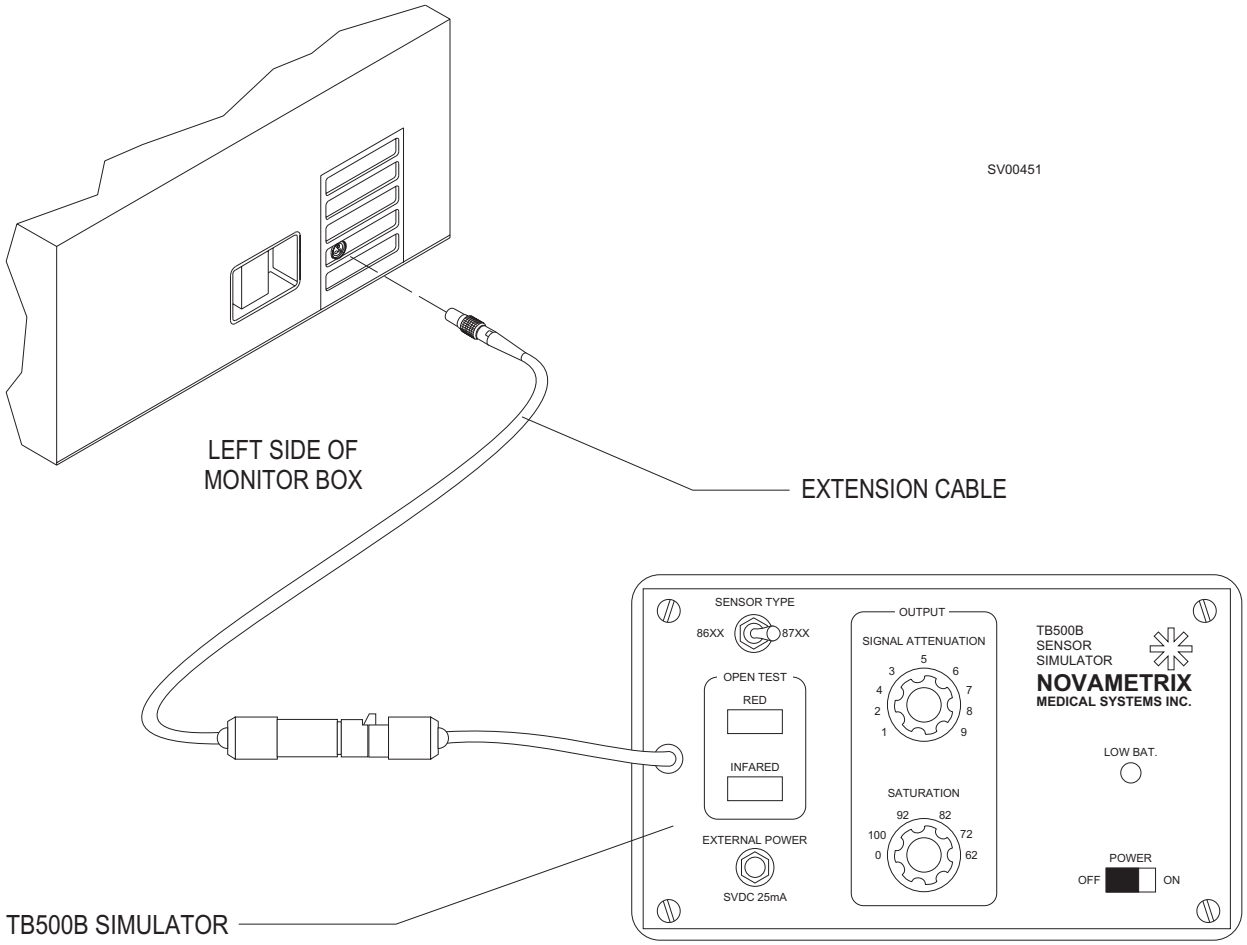



**Figure 5-11: (continued) SpO2 CALIBRATION CONNECTIONS (NOVAMETRIX)**

## 5.12 NIBP Inflation Pressure Calibration Check

5.12.1 Set the System Power switch to ON.

5.12.2 Enter the main service screen by simultaneously pressing the MONITOR key, SYSTEM CONFIG key, and the Selection DIAL.

5.12.3 Touch the MONITORS key on the screen to bring up the second column of touch keys.

5.12.4 Touch the NIBP key on the screen.

5.12.5 Disconnect the BP cuff tubing at the interface panel, and insert a test fixture TEE assembly with an external pressure gauge.

5.12.6 Wrap the cuff loosely around a cylindrical object and fasten its closure.

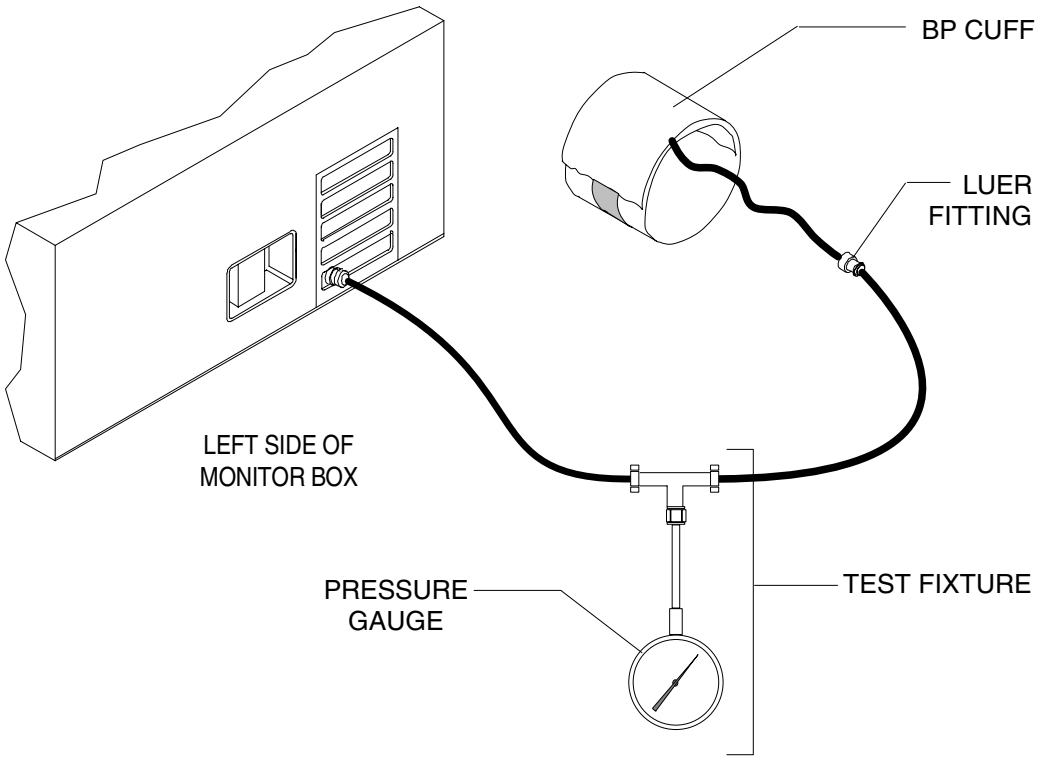
5.12.7 Touch the INFLATE key on the screen.

5.12.8 When the cuff is inflated, the external pressure gauge should read 180 mm Hg.

5.12.9 Touch the STOP key to end the test.

5.12.10 Disconnect the test fixture and connect the BP cuff tubing to the interface panel.

See Section 6 for inflation time, deflation time, and leakage tests.



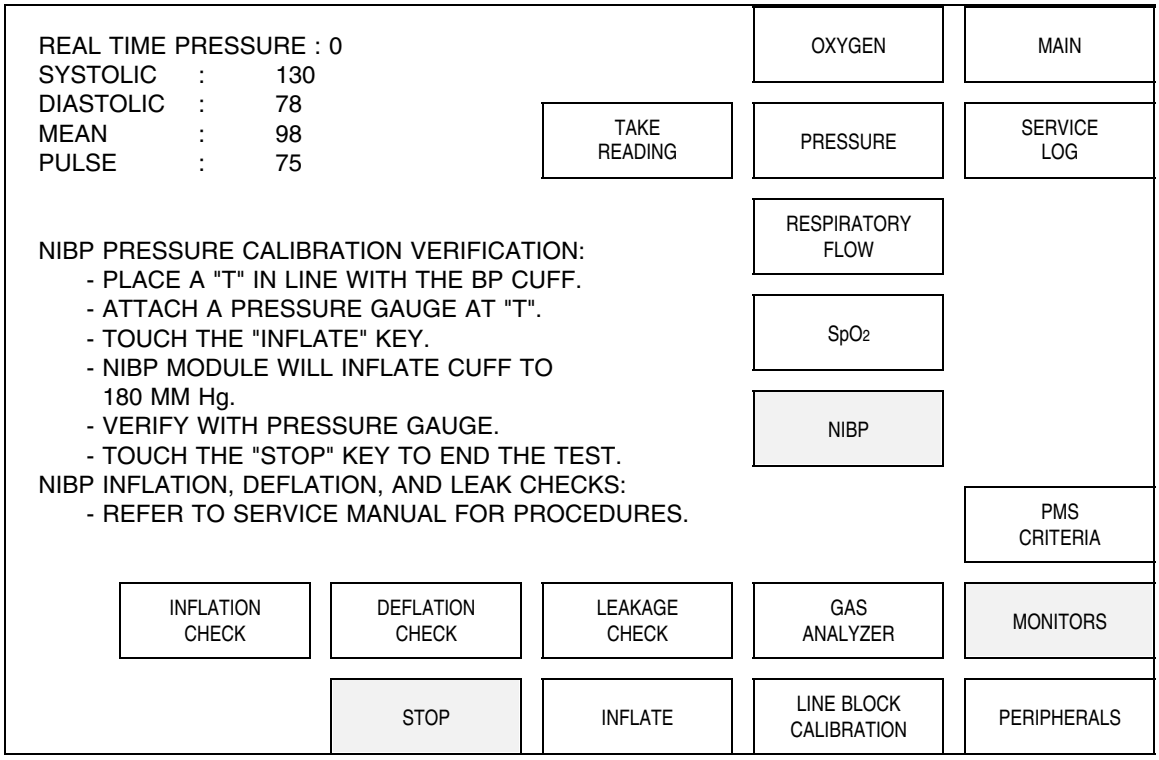




**Figure 5-12: NIBP INFLATION PRESSURE TEST SETUP AND SCREEN**

## 5.13 Multispec Span and Line Block Calibration

NOTE: Perform the pump flow rate adjustment and the oxygen sensor ambient air calibration before proceeding with the multispec calibration.

### 5.13.1 Multispec Pump Flow Rate Adjustment

5.13.1.1 Set the System Power switch to STANDBY.

CAUTION: Do not plug or unplug remote display with power applied.

5.13.1.2 Disconnect the following items from the patient interface panel on the left side of the monitor box:

-Remote Display cable

-BP Cuff and BP Gauge lines

-Pulse Oximeter Sensor cable

5.13.1.3 Disconnect the patient sample line.

5.13.1.4 Remove the six screws holding the monitor box cover, and carefully lift the cover from the monitor box.

5.13.1.5 Connect a test flowmeter to the exhaust port on the sensor interface panel, and connect the patient sample line to the disposable reservoir.

5.13.1.6 Set the System Power switch to ON.

5.13.1.7 Adjust the flow restrictor (see Figure 5-13) for a reading of 200 ml/min. on the test flowmeter.

5.13.1.8 Set the System Power switch to STANDBY, and disconnect the test flowmeter.

5.13.1.9 Replace the monitor box cover.

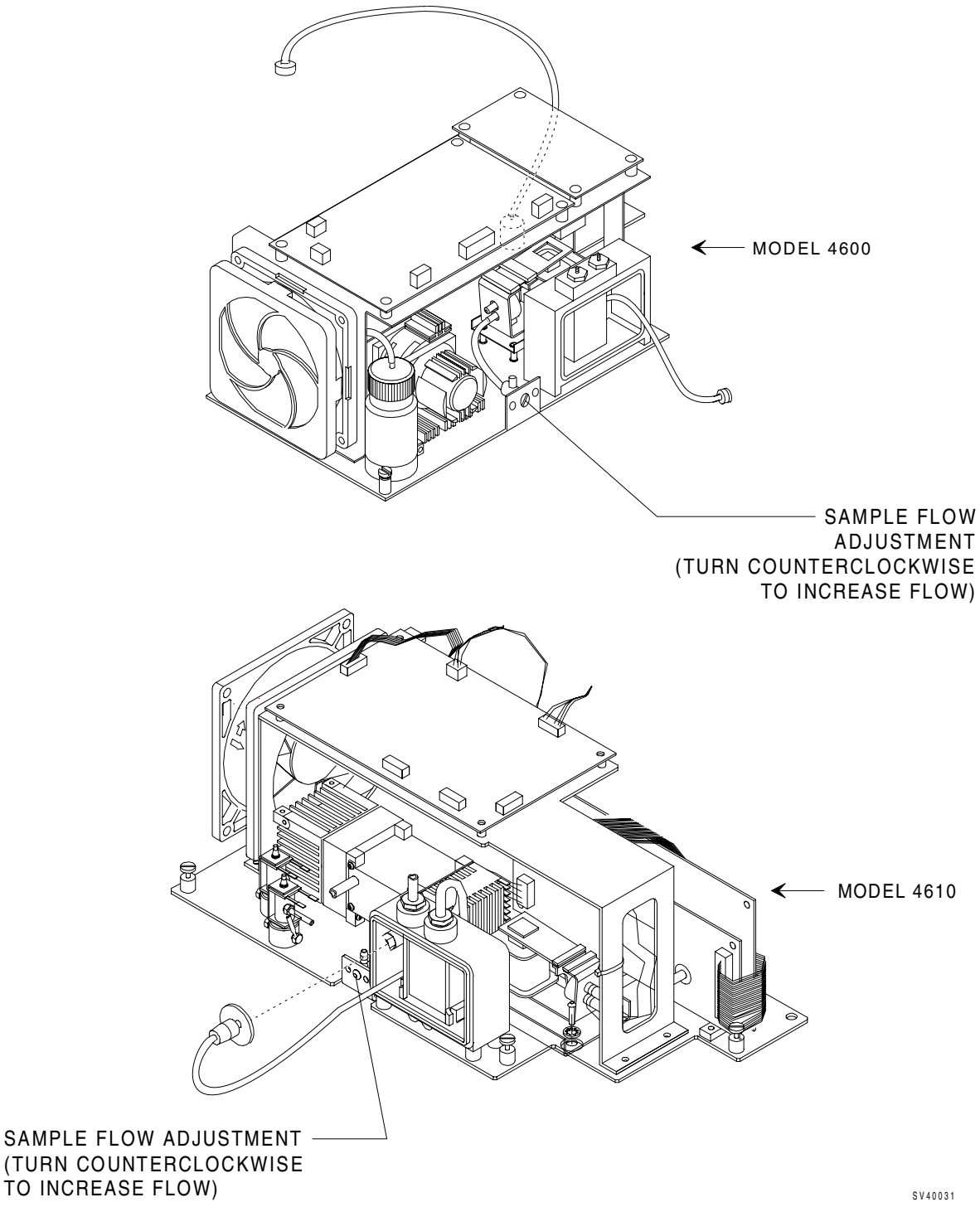



**Figure 5-13: MULTISPEC PUMP FLOW RATE ADJUSTMENT**

5.13.2 Oxygen Sensor Ambient Air Calibration:

5.13.2.1 Remove the sensor assembly from the inspiratory valve dome and close off the dome with the inspiratory valve dome plug. (Do not disassemble the sensor assembly further.)

5.13.2.2 Expose the sensor to ambient air only (away from any open part of the breathing system) and allow it to stabilize for several minutes.

5.13.2.3 When the sensor is exposed only to room air, press the "MONITOR SETUP" key on the main key panel, then the "$O_2$ CAL" soft key on the $CO_2$ & $O_2$ display area.

The length of time that the sensor takes to calibrate depends on the gas mixture to which the sensor had been exposed prior to calibration. If the sensor had been exposed to 21% oxygen for greater than one minute, calibration can take as little as 10 seconds. If the sensor had been exposed to higher concentrations of oxygen, calibration may last up to 50 seconds. Typically, calibration will last less than 30 seconds.

5.13.2.4 When the NARKOMED 4 has completed calibration, pull the inspiratory valve dome plug and re-insert the sensor assembly.

NOTE: Before attempting a span calibration, perform the following accuracy test to determine whether calibration is necessary.

5.13.3 Multispec Accuracy Test:

5.13.3.1 Attach a $CO_2$ cylinder adapter (NAD P/N 4110216) to the $CO_2$ verification gas cylinder (NAD P/N 4107979).

NOTE: Do not use the calibration gas cylinder, NAD Part No. 4110599 or 4110599-001, to perform the accuracy test.

5.13.3.2 Set the System Power switch to ON.

5.13.3.3 Remove the oxygen sensor from the inspiratory valve to expose the sensor capsule to ambient air.

5.13.3.4 Touch the PAT key on the monitor setup screen.

5.13.3.5 Enter the main service screen by simultaneously pressing the MONITOR key, SYSTEM CONFIG key, and the Selection DIAL.

5.13.3.6 Touch the MONITORS key on the screen to bring up the second column of touch keys.

5.13.3.7 Touch the GAS ANALYZER key on the screen.

5.13.3.8 Wait for a Mode message of "READY".

5.13.3.9 Connect the output of the cylinder adapter to the sample line on the disposable reservoir on the left side of the monitor box. Make sure that the Luer-lock connections are tight.

5.13.3.10 Open the calibration gas cylinder valve so that an audible flow of gas can be heard.

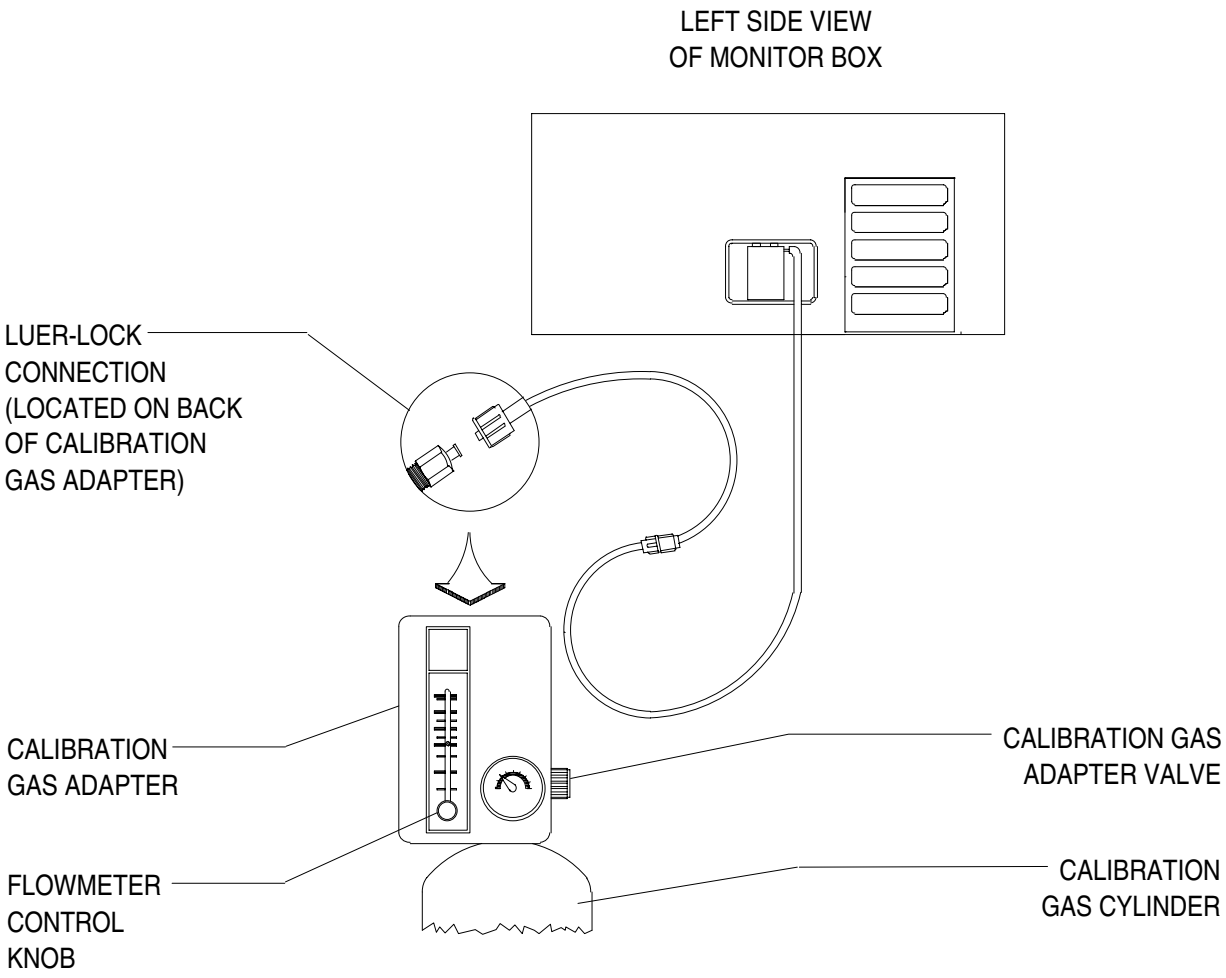



**Figure 5-14: MULTISPEC CALIBRATION CONNECTIONS**

5.13.3.11 Observe the current values of $CO_2$, $N_2O$, and Agent displayed on the screen.

When checking the multispec accuracy against a known standard, the maximum possible error range must be considered. The total allowable error range is the summation of the multispec accuracy tolerance, the noise specification, and the error percentage of the calibration gas.

For example, if a calibration gas that contains 2 vol % Enflurane has a stated maximum error percentage of ±2%, one must first calculate the error percentage of Enflurane in the calibration gas, which is ±2% of 2%, or 0.04% absolute. Adding this figure to those obtained from Table 5-1, the maximum possible error range would be (±0.2) + (±0.1) + (±0.04), or ±0.34 vol %. Since the known standard contains 2% Enflurane, a multispec reading for Enflurane that is between 1.66% and 2.34% is within specifications.

**Table 5-1: MULTISPEC ACCURACY AND NOISE SPECIFICATIONS**

| Gas Measurement | Accuracy (full accuracy mode) | Noise |
|---|---|---|
| Carbon Dioxide | ±2.0 mm Hg (0 to 40 mm Hg)<br>±2.5 mm Hg (41 to 60 mm Hg)<br>±4.0 mm Hg (61 to 80 mm Hg) | 0.5 mm Hg<br>2.0 mm Hg<br>3.0 mm Hg |
| Nitrous Oxide | ±7.5 vol % $N_2O$ | 3 vol % $N_2O$ |
| Halothane | ±0.2 vol % Hal, or 10% of reading* | 0.2 vol % Hal |
| Enflurane | ±0.2 vol % Enf, or 10% of reading* | 0.1 vol % Enf |
| Isoflurane | ±0.2 vol % Iso, or 10% of reading* | 0.1 vol % Iso |

* Whichever is greater

5.13.3.12 Disconnect the sample line from the cylinder adapter and close the cylinder valve.

5.13.3.13 If the accuracy test produces readings that have greater than the maximum permissible error range, proceed to Step 5.13.4. and perform a span calibration.

5.13.3.14 If the readings are within specifications, a span calibration is not necessary. Proceed to Step 5.13.5.

5.13.4 Span calibration procedure:

5.13.4.1 Mount the calibration gas adapter (NAD P/N 4110716) on the calibration gas cylinder, (NAD Part No. 4110599 or 4110599-001). See Figure 5-14.

5.13.4.2 Set the System Power switch to ON.

5.13.4.3 Remove the oxygen sensor from the inspiratory valve to expose the sensor capsule to ambient air.

5.13.4.4 Enter the main service screen by simultaneously pressing the MONITOR key, SYSTEM CONFIG key, and the Selection DIAL.

5.13.4.5 Touch the MONITORS key on the screen to bring up the second column of touch keys.

5.13.4.6 Touch the GAS ANALYZER key on the screen.

5.13.4.7 Wait for a Mode message of "READY".

5.13.4.8 Touch the START key. A Status message of "ZERO IN PROGRESS" will be displayed.

5.13.4.9 Wait for a Status message of "ZERO COMPLETE".

5.13.4.10 Connect the output of the calibration gas adapter to the sample line on the disposable reservoir on the left side of the monitor box. Make sure that the Luer-lock connections are tight.

5.13.4.11 Set the calibration gas flow to 250 ml/min.

5.13.4.12 After the current values stabilize, disconnect the sample line from the calibration gas adapter and close the cylinder valve.

5.13.4.13 Touch the CONTINUE key. A Status message "SPAN IN PROGRESS" will be displayed during the calibration procedure.

When the span calibration is complete, the message "PASSED" will be displayed on the screen.

If a "FAILED" message appears, the multispec unit must be replaced.

The MODE window on the gas analyzer screen displays the following messages:

INHIBIT during warm-up
READY after 30 minute warm-up

The STATUS window on the gas analyzer screen displays the following messages:

ZERO IN PROGRESS, ZERO COMPLETE, SPAN IN PROGRESS during calibration

PASSED or FAILED after calibration

NOTE: The scrubber bottle replacement instruction is not displayed on machines having a Model 4610 gas analyzer.

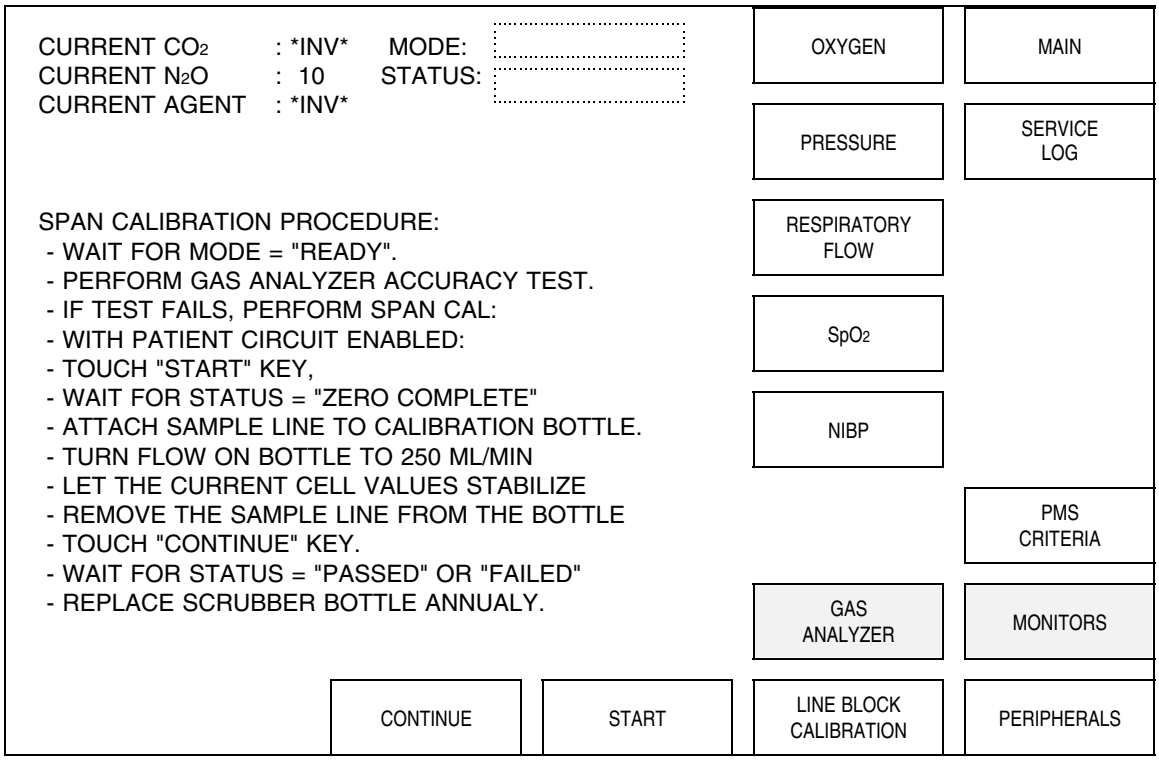



**Figure 5-15: MULTISPEC SPAN CALIBRATION SCREEN**

### 5.13.5 Line Block Calibration Procedure

5.13.5.1 Ensure that the full length of the patient sample line is connected to the disposable reservoir on the left side of the monitor box and is unoccluded.

5.13.5.2 Connect a flowmeter to the exhaust port on the sensor interface panel.

5.13.5.3 Connect a variable flow restrictor to the patient sample line.

5.13.5.4 Set the System Power switch to ON.

5.13.5.5 Enter the main service screen by simultaneously pressing the MONITOR key, SYSTEM CONFIG key, and the Selection DIAL.

5.13.5.6 Touch the MONITORS key on the screen to bring up the second column of touch keys.

5.13.5.7 Touch the LINE BLOCK CALIBRATION key on the screen.

5.13.5.8 Wait for the current sample pressure to stabilize, and a Mode messasge of "READY".

5.13.5.9 Adjust the restrictor on the patient sample line to obtain a flowmeter reading of 100 ml per minute.

5.13.5.10 Touch the STORE REFERENCE key.

5.13.5.11 Fully occlude the patient sample line and observe that the line block alarm becomes active after at least 15 seconds.

5.13.5.12 Turn the System Power switch to STANDBY, then return it to the ON position to retain the new value.

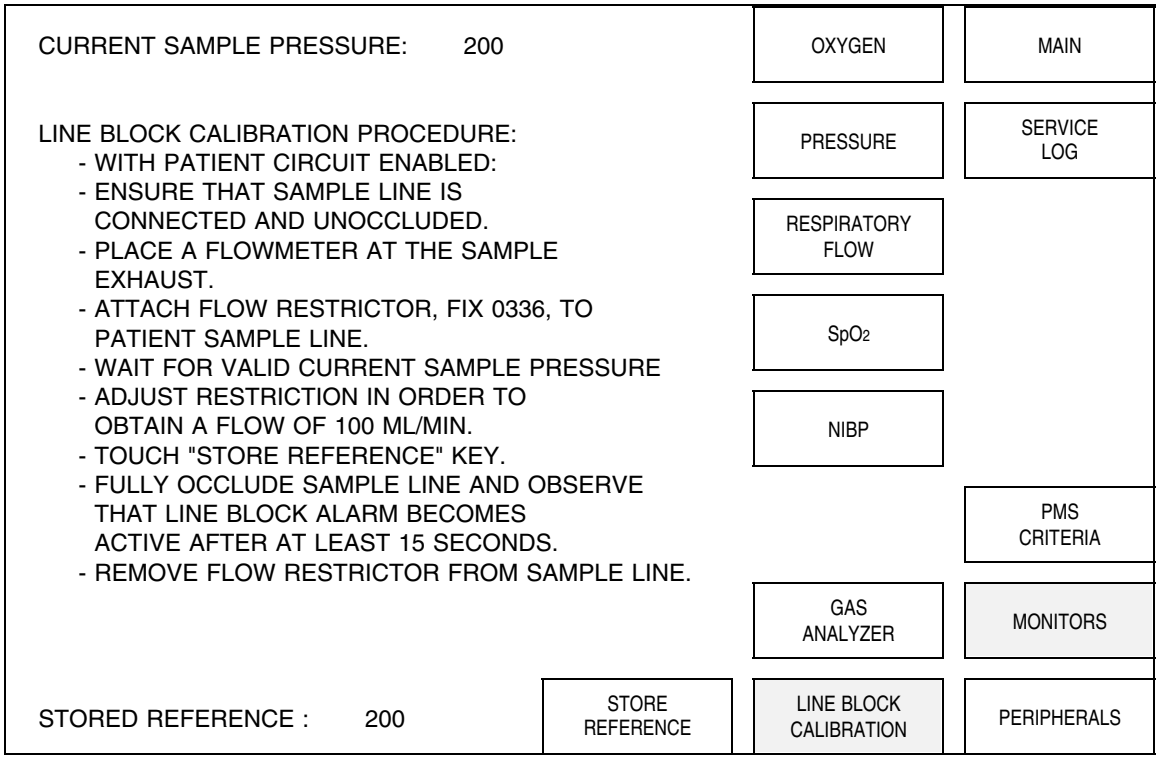

CURRENT SAMPLE PRESSURE: 200
LINE BLOCK CALIBRATION PROCEDURE:
- WITH PATIENT CIRCUIT ENABLED:
- ENSURE THAT SAMPLE LINE IS CONNECTED AND UNOCCLUDED.
- PLACE A FLOWMETER AT THE SAMPLE EXHAUST.
- ATTACH FLOW RESTRICTOR, FIX 0336, TO PATIENT SAMPLE LINE.
- WAIT FOR VALID CURRENT SAMPLE PRESSURE
- ADJUST RESTRICTION IN ORDER TO OBTAIN A FLOW OF 100 ML/MIN.
- TOUCH "STORE REFERENCE" KEY.
- FULLY OCCLUDE SAMPLE LINE AND OBSERVE THAT LINE BLOCK ALARM BECOMES ACTIVE AFTER AT LEAST 15 SECONDS.
- REMOVE FLOW RESTRICTOR FROM SAMPLE LINE.
STORED REFERENCE : 200
STORE REFERENCE
OXYGEN
PRESSURE
RESPIRATORY FLOW
SpO2
NIBP
GAS ANALYZER
LINE BLOCK CALIBRATION
MAIN
SERVICE LOG
PMS CRITERIA
MONITORS
PERIPHERALS

**Figure 5-16: MULTISPEC LINE BLOCK CALIBRATION SCREEN**

## 5.14 Vaporizer Interlock Adjustment

5.14.1 Set the System Power switch to STANDBY.

5.14.2 Turn the center vaporizer handwheel ON. The left and the right vaporizer handwheels should be locked in their Zero position. If the left or right vaporizer does not lock, tighten the corresponding center set screw until the handwheel locks properly.

5.14.3 Turn the center vaporizer OFF and turn the left vaporizer ON. The center and the right vaporizer handwheels should be locked in their Zero position. If the right vaporizer does not lock, loosen the locking nut on the right set screw and adjust the set screw until the handwheel locks properly. Tighten the locking nut while holding the set screw to maintain the correct adjustment.

NOTE: Do not over-tighten the set screws. Each vaporizer handwheel must turn easily while the other vaporizers are locked .

5.14.4 Turn the left vaporizer OFF and turn the right vaporizer ON. The center and the left vaporizer handwheels should be locked in their Zero position. If the left vaporizer does not lock, loosen the locking nut on the left set screw and adjust the set screw until the handwheel locks properly. Tighten the locking nut while holding the set screw to maintain the correct adjustment.

NOTE: When the interlock adjustment procedure is completed, ensure that all vaporizer handwheels are set to their zero or OFF position.

5.14.5 Perform the PMS Procedure given in Section 6.

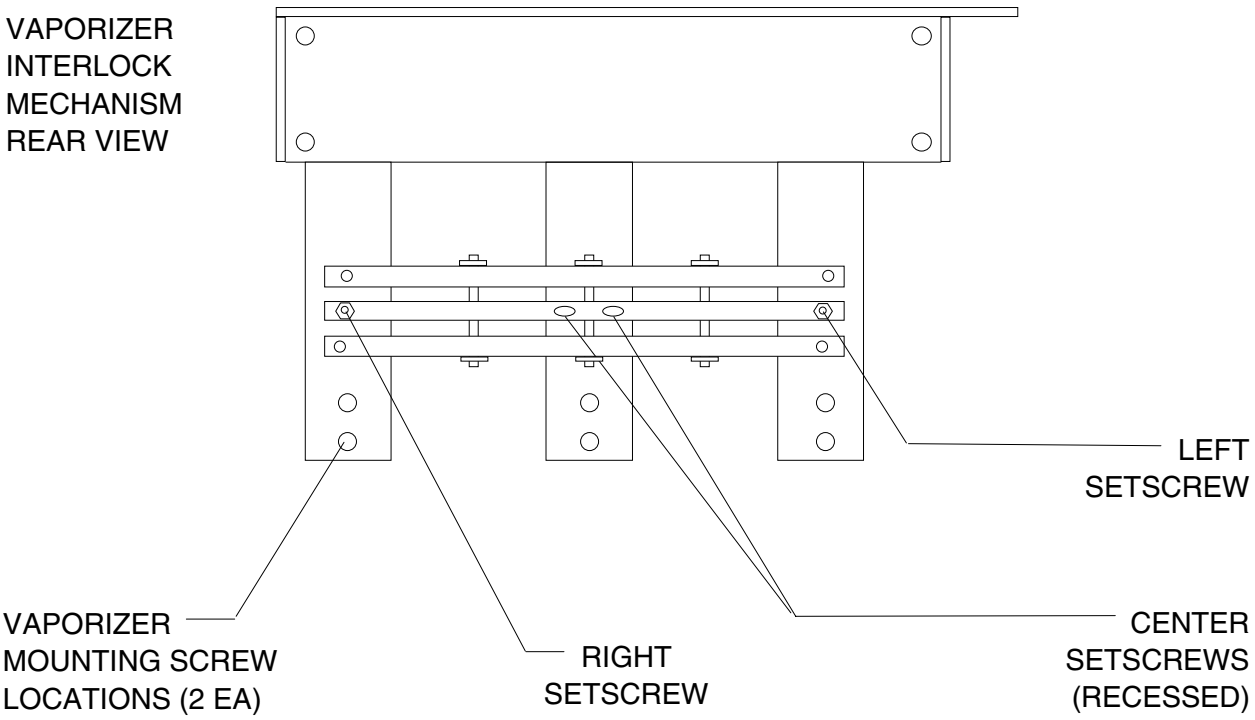



**Figure 5-17: VAPORIZER INTERLOCK ADJUSTMENT**

## 5.15 Vaporizer Select Switch Adjustment

5.15.1 Set the System Power switch to STANDBY.

5.15.2 Remove the four screws holding the rear panel of the vapor box, and remove the panel.

5.15.3 If applicable, remove the two screws holding the oxygen ratio monitor/controller to the bottom panel of the vapor box. Remove the four screws holding the bottom panel of the vapor box, and remove the panel.

5.15.4 Remove the four screws holding the front cover. Carefully lower the cover so that it is supported by the wire harnesses joined to its circuit board.

5.15.5 At the circuit board, disconnect the wire harness for the switch that is being adjusted, and connect an ohmmeter to the wire harness.

5.15.6 With the corresponding vaporizer handwheel at zero, the switch should be open. When the vaporizer is turned on, the switch contacts should close.

Loosen the adjusting screw locknut and turn the adjusting screw to raise or lower the switch bracket until the correct action is achieved. Tighten the locknut when the adjustment is completed.

NOTE: When the switch adjustment procedure is completed, ensure that the vaporizer handwheel is returned to its zero or OFF position.

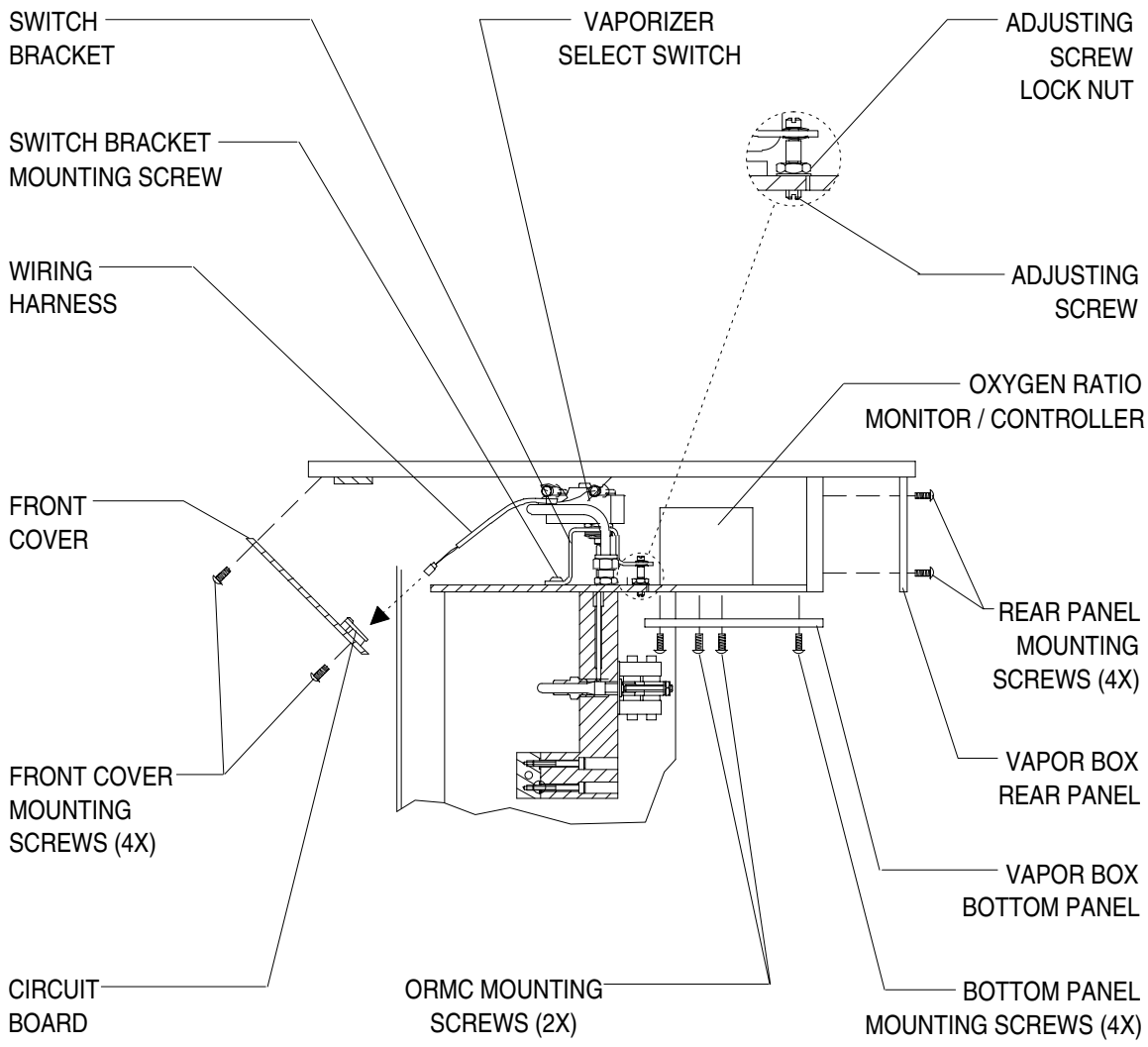
5.15.7 Disconnect the ohmmeter and connect the wiring harness to the circuit board.

5.15.8 Replace the front cover, carefully guiding the gas selector switch cam into its spring, and secure the cover with its four mounting screws.

5.15.9 Replace the bottom panel of the vapor box and secure it with the four screws. If applicable, replace the two screws that hold the oxygen ratio monitor/controller to the bottom panel.

5.15.10 Replace the rear panel of the vapor box and secure it with the four screws.

5.15.11 Perform the PMS Procedure given in Section 6.




NARKOMED 4 RIGHT SIDE VIEW CUT-AWAY
SHOWING TYPICAL VAPORIZER SELECT
SWITCH MOUNTING ARRANGEMENT

**Figure 5-18: VAPORIZER SELECT SWITCH ADJUSTMENT**

## 6.0 PMC PROCEDURE, NARKOMED 4

The procedures in this section shall be performed in their entirety each time a component is removed, replaced, calibrated, adjusted and during all scheduled Periodic Manufacturer's Certification (PMC) visits. A PMC Checklist form, P/N S010052, available from the Draeger Medical, Inc. Technical Service Department, shall be completed by the TSR each time a PMC is performed. Steps in the procedure marked with (✓) require a response at the corresponding line on the checklist form.

Space is also provided on the PMC checklist form to record the results of a vapor concentration test.

Test equipment listed below with an asterisk (*) require calibration at a maximum interval of one year.

NOTE: Verify the dates on test equipment calibration labels. DO NOT USE any test equipment having an expired calibration date. Notify your supervisor immediately if any equipment is found to be out of calibration.

In the space provided at the bottom of the PMC checklist form, record the Model and ID number of all calibrated test equipment used. Also record the calibration due dates.

Test Equipment Required:
-- Nellcor PT2500 pocket tester (for SpO2 cal check)
*-- Novametrix TB500B sensor simulator (for SpO2 cal check)
*-- Multi-Meter (Fluke or equivalent)
*-- Electrical Safety Analyzer (Biotek 501 Pro or equivalent)
*-- Regulator Test Pressure Gauge, P/N S000063 or equivalent
-- Fresh Gas Outlet Volume Test Device, P/N S010158 or equivalent
-- Fresh Gas Leak Test Device, P/N 4113119 or equivalent
-- Adapter Assembly, Test Terminal, P/N 4104389 or equivalent: two are required
*-- Flowmeter Test Stand (Capnomed), P/N S000081 or equivalent
-- Breathing System Leak Test Device, P/N S010159 or equivalent
-- Baromed Pressure Test Fixture or equivalent
*-- Test Minute Volume Meter, P/N 2212300 or equivalent
*-- Digital Pressure Manometer (SenSym PDM 200CD or Equivalent)
*-- Riken Gas Indicator, Model 18H, or 1802D or equivalent
-- Stop Watch
-- Service Test Lung, P/N 4115128
Materials Required:
-- Dow Corning High Vacuum Grease, P/N S4105908
-- Spiromed Sensor Lubrication Kit, P/N 2218180
-- Breathing Bag, 3 liter, P/N 9995330
-- Tube, Corrugated, 22 mm x 12 in. long, P/N 9995112

Test equipment illustrations are shown on following pages.

NOTE: The following calibrations must be performed before beginning the PMC Procedure (refer to Section 5 in the Narkomed 4 Service Manual, Adjustment and Calibration Procedures):

Oxygen Sensor Zero Calibration

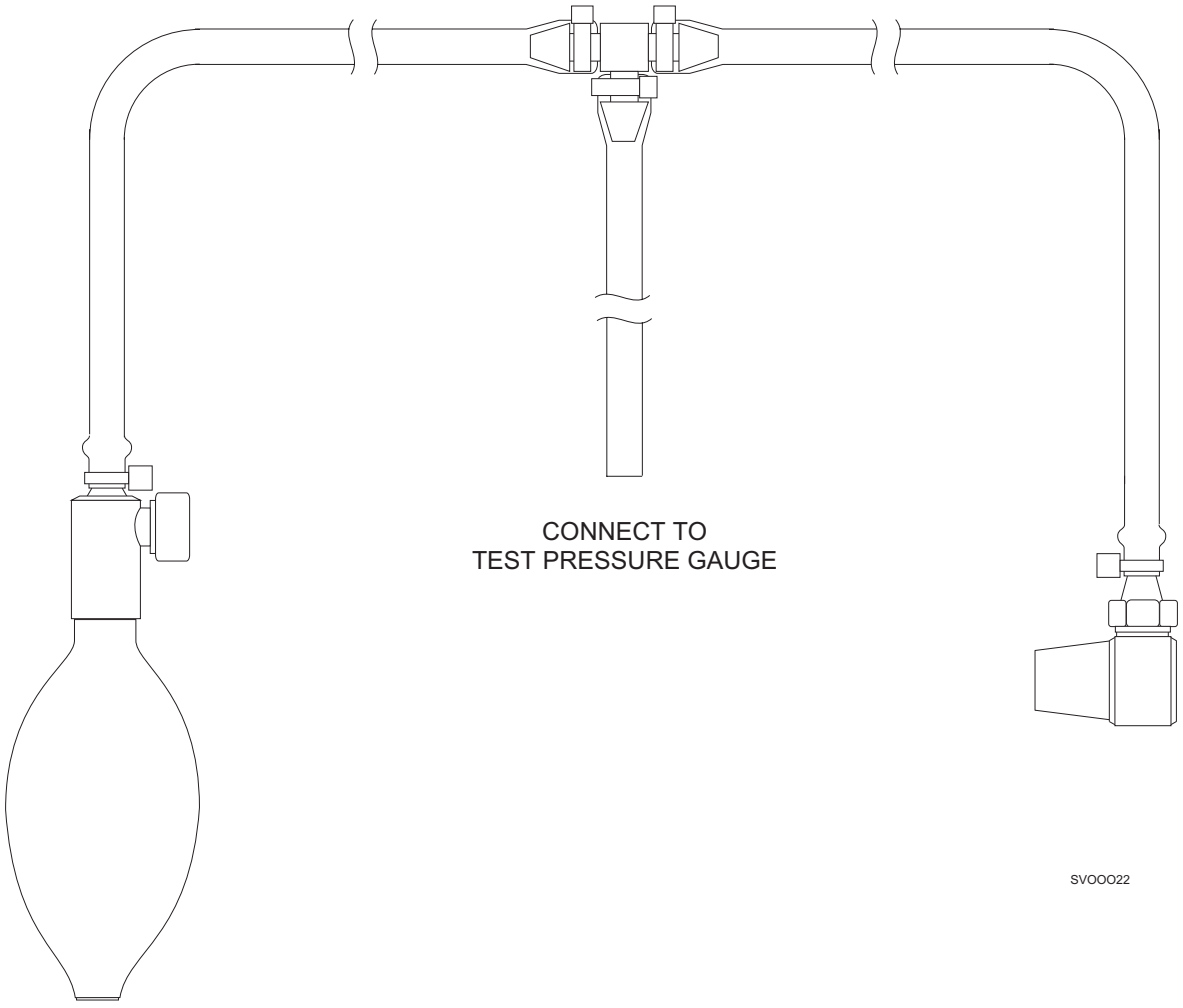
Breathing Pressure Monitor Calibration

Respiratory Flow Monitor Calibration

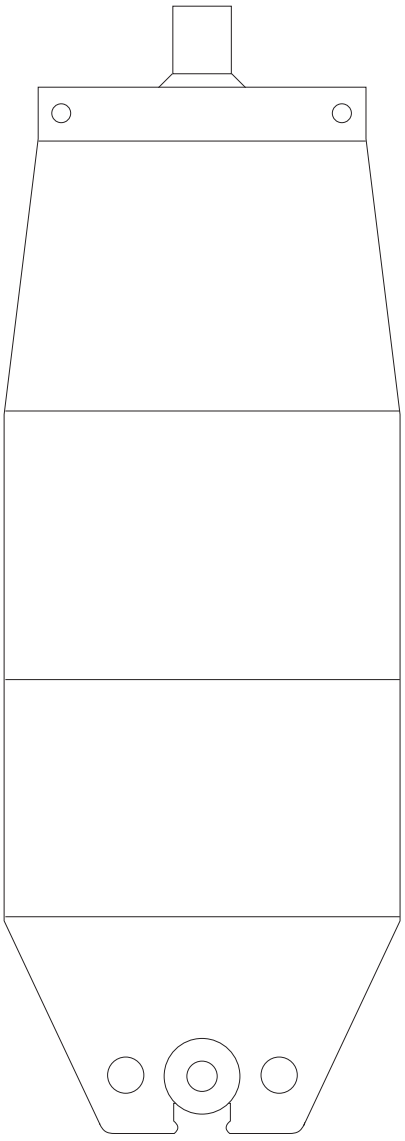
$SpO_2$ Monitor Calibration Check

NIBP Inflation Pressure Calibration Check

4113119
FRESH GAS LEAK TEST DEVICE

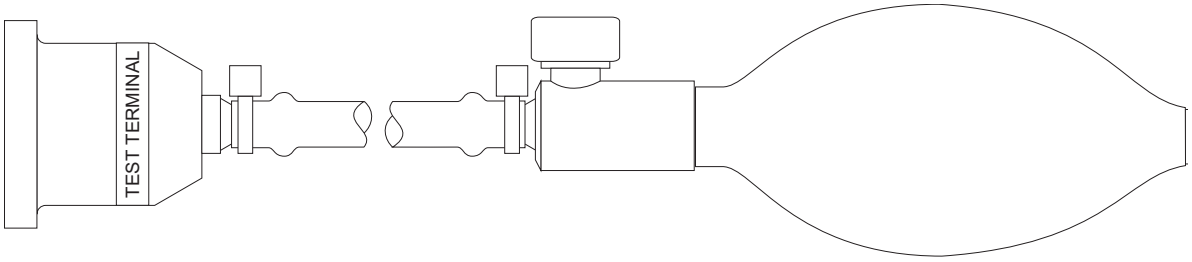


**PMC PROCEDURE (continued)** **NM4**

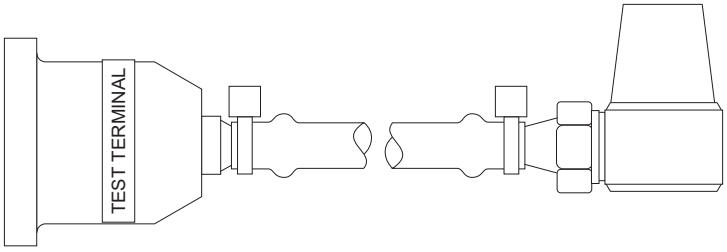


4115128
SIEMENS TEST LUNG

SVOOO25



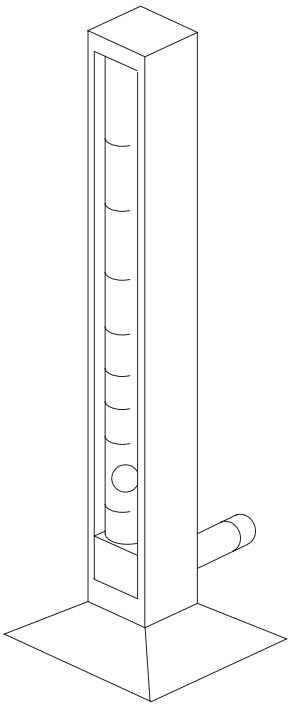

S010159
BREATHING SYSTEM LEAK TEST DEVICE



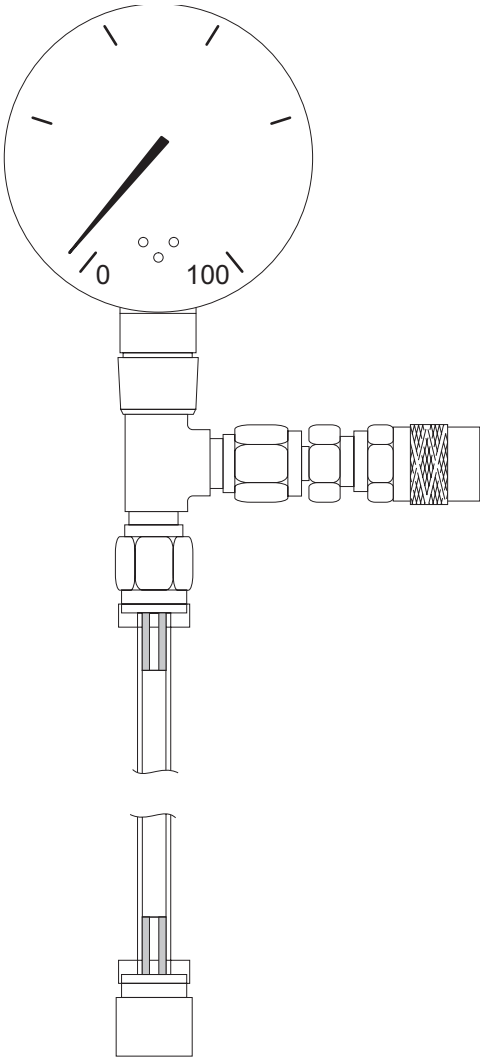

SVOOO23

S010158
FRESH GAS OUTLET VOLUME TEST DEVICE

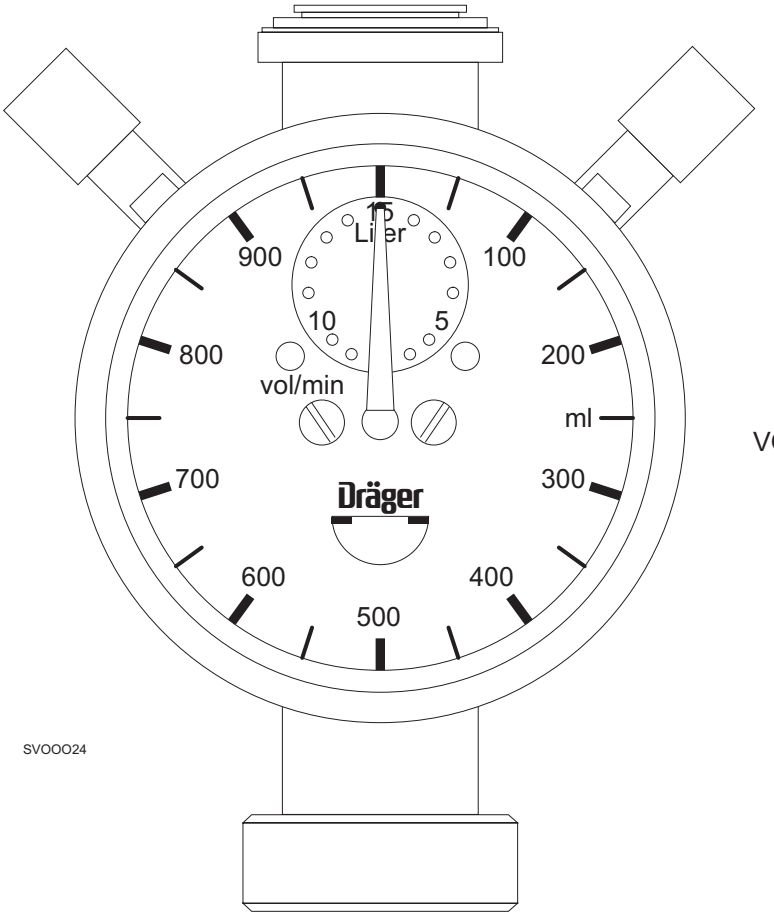
SVOOO27



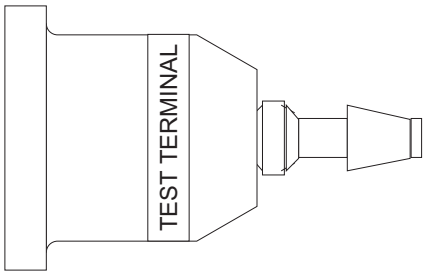
S000081
FLOW METER
TEST STAND



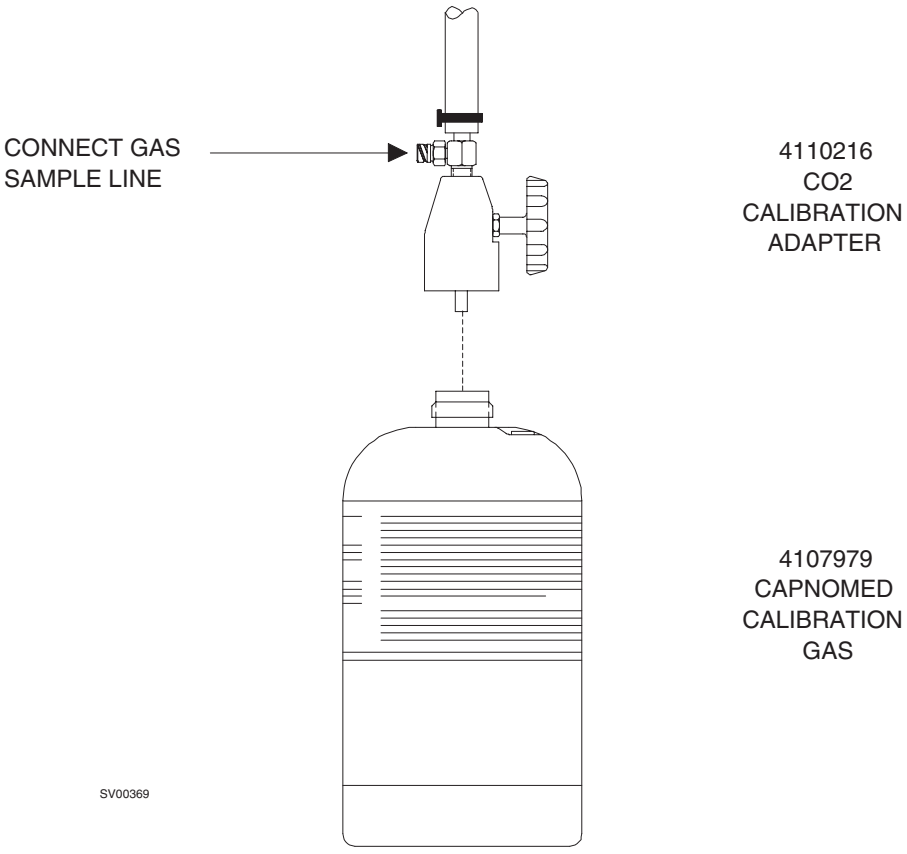

S000063
REGULATOR TEST
PRESSURE GAUGE



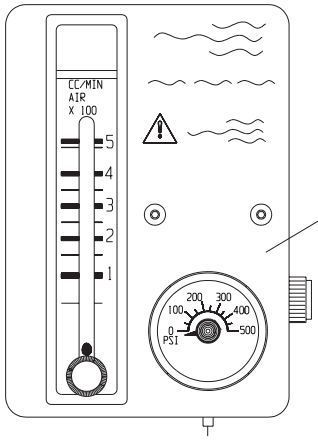

2212300
MINUTE
VOLUMETER



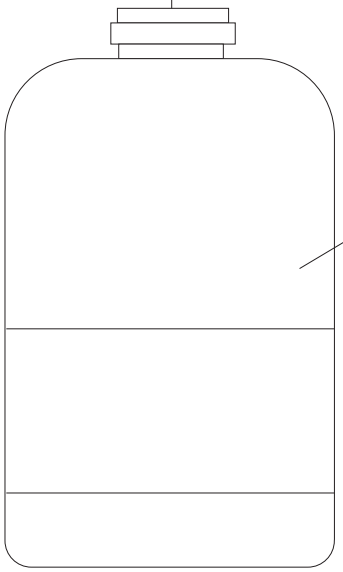

4104389
TEST TERMINAL
ADAPTER




TEST EQUIPMENT FOR AGENT
ANALYZER ACCURACY TEST




4110716
MULTISPEC CALIBRATION ADAPTER



4110599 OR 4110599-001
MULTISPEC CALIBRATION
GAS CYLINDER

SVOOO26

4110683
MULTISPEC CALIBRATION KIT

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## Periodic Manufacturer's Certification General Instructions

The purpose of these procedures is to provide detailed instructions for performing a Periodic Manufacturer's Certification (PMC) inspection on the Narkomed 4 anesthesia machine.

A PMC consists of a complete Periodic Manufacturer's Service procedure and a new certification level inspection based on Draeger Medical, Inc. Recommendations and equipment performance. Additional inspections are also performed to insure proper product labeling.

Several additional documents have been created to ensure the success of this new program. Following is a brief description of the purpose of each document.

Field Service Procedure:
Periodic Manufacturer's Certification Forms - Part Number SP00175.
This procedure illustrates sample checklists with typical periodic maintenance items filled in, including vapor concentrations verification tests, parts replaced, general comments and certification levels. Also included are sample PMC labels marked to show several levels of certifications. An excerpt from Draeger Medical, Inc.'s *Anesthesia System Risk Analysis and Risk Reduction* is included, and also a sample of an Executive Summary to be furnished to the hospital's Risk Manager or Chief of Anesthesia.

Field Service Procedure:
DMI Recommendations Guidelines Index Anesthesia Systems - Part Number S010250.
This Guideline was created to provide an assessment of each machine's certification. It contains various comprehensive overviews of possible equipment conditions and their associated certification levels.

The first list in the Recommendation Guidelines is a reference chart for machine certification based on equipment status. The second is an abbreviated summary of all DMI Recommendations and Failure Codes including the Condition Number, Equipment Condition, Recommended Corrections, Certification Code, and Tests Affected when applicable.

There is also a matrix classified as "Failure Codes" which identifies the correct manner in which to document equipment tests that fail, or were unable to be performed due to circumstances beyond the control of the service technician performing the inspection. (Ex: Air cylinder supply is unavailable to perform Air High Pressure Leak test.) The Failure Codes section also indicates suggested resolution of the situation. Failure Code numbers begin at 34 and use the same certification levels strategy, and carry the same weight as DMI Recommendation equipment condition codes.

The final matrix is the most comprehensive index sorted by machine model and includes Equipment Condition, Certification Code, and DMI Recommendations. It also specifies any suggested upgrade path including ordering information that should be taken such as installing a Bellows with Pressure Limit Control 4109664-S01 Kit, after market modification kit to a machine not equipped with pressure limit control.

The letters A, B, C, D and the Roman Numerals I, II are used as codes in the individual matrix for each model of anesthesia machine. The letters A, B, C, and D are used in descending order to indicate the certification level of the equipment. They are as follows:

A = Certified
B = Certified with Recommendations
C = Conditionally Certified
D = No Certification

Roman Numerals I and II do not affect the certification level but rather are provided to give further instructions to the end user as follows:

I = The system in its present configuration shall only be used with a CO2 monitor incorporating an apnea warning. The operator of the system is advised to frequently scan the CO2 readings and alarm thresholds.

II = The present configuration of equipment requires that the unit operate at all times with an oxygen analyzer that includes a low oxygen warning. The operator of the system is advised to frequently scan the oxygen readings and alarm limits.

Following is an explanation of machine certification levels:

**Certified-** No recommendations apply to machine being inspected. (Only item number 33 - "No Recommendations" shall apply for this certification level.)

**Certified with Recommendations-** A numbered recommendation with a code of B applies to the machine being examined.

**Conditionally Certified-** A numbered recommendation with a code of BCI or BCII applies to the machine being examined.

**No Certification-** A numbered recommendation with a code of D applies to the machine being examined.

When multiple recommendations apply, "No Certification" would take precedence over "Conditionally Certified" and "Certified with Recommendations". "Conditionally Certified" would take precedence over "Certified with Recommendations".

For example:

A **Narkomed 3** could have recommendation number 21 and failure code 61.1 apply.
21 - No ventilator pressure limit control. Code is B.
61.1 - Enflurane agent is unavailable to test. Code is BC.
Correct certification for this machine is BC, which means CONDITIONALLY CERTIFIED WITH RECOMMENDATIONS.

A **Narkomed** 4 could have recommendation numbers 14 and 21 apply.
14 - CO2/Agent monitor exhaust port is not properly connected to the waste gas scavenger. Code B.
21 - No ventilator pressure limit control. Code B.
The correct certification for this machine is B, which means CERTIFIED WITH RECOMMENDATIONS.

A **Narkomed 2B, 2**C or **GS** could have recommendation 30 apply.
30 - Anesthesia machine is equipped with inhalation anesthesia vaporizers without an agent analyzer in the breathing system. Code B.
The correct certification for this machine is B, which means CERTIFIED WITH RECOMMENDATIONS.

A **Narkomed 6000** could have no DMI recommendations or failure codes apply. The correct certificaiton level for this machine is Code A, CERTIFIED.

**Code D, which means NO CERTIFICATION, also means the machine shall not receive a Periodic Manufacturer's Certification label. The machine shall also receive a 'WARNING - This System is Not Certified' label, P/N 4114857. This label shall be placed at a prominent location on the right side of the machine after all other previous PM and 'Vigilance Audit® Validation' labels have been removed.**

## PM Certification Procedure for Narkomed 4 Anesthesia System

1. Use the PM Certification form for Narkomed 4 Anesthesia Systems (P/N S010052).

2. Completely fill in the header information.

3. Determine if the ventilator has an MJV-2 square Clippard valve. If ventilator has an MJV-2, perform the lubrication procedure in accordance with SP00062. Write in the date of lubrication next to the "MJV-2 LUBRICATION" line on the Periodic Manufacturer's Certification form. If the ventilator has a Humphrey valve, indicate so with a (H) next to the "MJV-2 LUBRICATION" line on the Periodic Manufacturer's Certification form.

4. Replace the VENTILATOR RELIEF VALVE DIAPHRAGM in accordance with SP00075. Place a check mark and the replacement date at "VENT RELIEF VALVE REPLACEMENT" line on the Periodic Manufacturer's Certification form.

5. If a TEC 6 DESFLURANE vaporizer is mounted to the machine, a label stating: "WARNING THE ADMINISTRATION OF DESFLURANE ANESTHESIA MAY REQUIRE FRESH GAS CONCENTRATIONS HIGHER THAN COMMONLY USED WITH OTHER VOLATILE ANESTHETIC AGENTS. O2 FRESH GAS CONCENTRATION OF LESS THAN 21% MAY BE OBTAINED WITH HIGH VAPORIZER SETTINGS. CONTINUOUS MONITORING OF THE O2 CONCENTRATION IN THE BREATHING SYSTEM IS THEREFORE REQUIRED. DRAEGER MEDICAL, INC. RECOMMENDS THE CONTINUOUS MONITORING OF THE CONCENTRATION OF ANESTHETIC VAPORS IN THE BREATHING SYSTEM DURING THE ADMINISTRATION OF INHALATION ANESTHESIA."(part # 4112737-001) Shall be attached to the vapor box immediately above the TEC 6 vaporizer.

6. Check all vapor 19 and 19.1 vaporizers for correct labeling. All vaporizers must have a label stating "THE CONCENTRATION OUTPUT OF THIS VAPORIZER SHALL BE VERIFIED AFTER IT HAS BEEN ATTACHED TO THE ANESTHESIA MACHINE" (part # S010015). This label shall be attached to the rear of the vaporizer directly below the mount.

7. All Key Index Safety Systems vaporizers, (K.I.S.S.) must have a label stating "CAUTION: AFTER FILLING HAS BEEN COMPLETED, REINSERT PLUG INTO UPPER FILLER PORT AND TIGHTEN LOCKING SCREW" (part # 4112520-001). This label shall be attached to the vaporizer directly above the keyed filler. Place a check mark at "K.I.S.S. LABEL" on the PM Certification form.

8. If machine is equipped with a HALOTHANE Dräger Vapor 19 or 19.1 vaporizer, determine if vaporizer must be inspected for soil condition one. Check the serial number plate located on the rear of the vaporizer for a plus (+) preceding the serial number. A HALOTHANE vaporizer serial number not preceded with a (+) must be tested for soil in accordance with SP00073. If vaporizer does not need to be inspected, indicate so with a plus (+) next to the "Vapor Inspection (H)" line on the Vigilance Audit form. If vaporizer is soil condition 0, indicate so with "SOIL 0" written next to the "Vapor Inspection (H)" line on the Vigilance Audit form. If vaporizer is soil one, indicate so with "SOIL 1" written next to the "Vapor Inspection (H)" line on the Vigilance Audit form. Place a "CAUTION DO NOT USE" label (part # 4114327) on the vaporizer, and issue a departmental alert. The TSR shall also seek permission from the equipment operator to remove the failed vaporizer from the machine and apply a replacement vaporizer or an adapter block onto the mount. All "SOIL 1" vaporizers must be removed from service for machine to receive certification.

9. Perform the vapor concentration test on all Dräger vapor vaporizers in accordance with SP00073 at a six month maximum interval. Perform the vaporizer concentration test on all Desflurane vaporizers in accordance with SP00091 for fixed mount vaporizers and SP00189 for user removable D-tec vaporizers at a six month maximum interval. For every vaporizer tested, fill out a "VAPOR VAPORIZER CALIBRATION CHECK" label (part # S010016). Information on this label shall include your signature, type of agent, date tested, test results @ 1%, 2.5%, 4% for H, E, I, or S vaporizers, or @ 4%, 10%, 12%, 16% for Desflurane vaporizers, and a PASS or FAIL indication. This label shall be attached to the upper right side of the vaporizer. If vaporizer fails the concentration verification, internal leak, or exclusion system tests, check "NO" in the "RECOMMENDED FOR USE" section on the PM Certification form.

## PM Certification Procedure for Narkomed 4 Anesthesia System

Place a "CAUTION DO NOT USE" label (part # 4114327) on the vaporizer, and issue a departmental alert. The TSR shall also seek permission from the equipment operator to remove the failed vaporizer from the machine and install a replacement vaporizer or an adapter block onto the mount. All nonfunctional Dräger vapor vaporizers must be removed from service for machine to receive certification.

10. Proceed with PM Certification procedure. If any tests fail refer to the "Failure Codes" listing in DMI Recommendations Guidelines Index (P/N S010250) to determine correct certification level starting point. Failure codes shall be documented on the "RECOMMENDATIONS / GENERAL COMMENTS" section of the PM Certification form and on the Executive Summary. If a test fails that has not been identified by the "Failure Codes" list, consult with Draeger Medical, Inc. to assess the proper certification level.

11. Based on the "EQUIPMENT CONDITION" inspect the machine for any "DMI RECOMMENDATIONS" that would apply. Use the Narkomed 4 section of the "RECOMMENDATION GUIDELINES INDEX" (P/N S010250). Note all applicable DMI recommendations on the Executive Summary. NOTE: If using a carbon form, indicate the Equipment Condition number and to see reverse side under the "RECOMMENDATIONS / GENERAL COMMENTS" section of the form.

12. Determine the correct certification level of the machine based on the combined lowest common denominator of "Equipment Conditions" and "Failure Codes". If the machine is at least conditionally certified fill out the ""PM CERTIFICATION" label. Check the box(s) on the validation label where appropriate. Write the month and year, (three months from date of PM Certification) next to "NEXT VISIT DUE:" If certification level is "D", machine shall not receive a "PM CERTIFICATION" label. Any machine not receiving a PM Certification label shall receive a "WARNING NOT CERTIFIED" label. This label shall be placed at a prominent location on the left side of the machine after all other previous PMC and Vigilance Audit Validation labels have been removed.

13. In the "CERTIFICATION LEVEL" section of the PM Certification form, record the last visit certification level, the current certification level and the next visit due month and year, (three months from date of PM Certification) in the spaces provided.

14. If applicable, remove the previous PM CERTIFICATION VALIDATION label and attach the new label (P/N S010006 w/phone #, or P/N S010007 w/o phone #) in a prominent location on the rear of the anesthesia machine.

15. Check the appropriate boxes on the "PM CERTIFICATION NOTICE" label, (part # S010011). If the machine is not certified, the last box of this notice label shall be marked. Attach this notice to the flow shield of the anesthesia machine.

16. Have the customer sign each PM Certification form or the Executive Summary, and review the equipment conditions and the recommendations with the customer.

17. Return top copy to Draeger Medical, Inc. Service Department, keep middle copy for service organization records, give bottom copy to customer.

## 6.1 Safety Testing

### 6.1.1 Protective Ground Continuity Test

6.1.1.1 Turn the System Power switch to STANDBY.

CAUTION: Do not plug or unplug the remote display cable with power applied.

Disconnect the remote display cable, NIBP hose, gas sample line, and $SpO_2$ cable.

Remove the monitor box cover and re-connect the remote display cable, NIBP hose, gas sample line, and $SpO_2$ cable.

NOTE: Do not plug the safety analyzer power cord into a line isolation monitor, as inaccurate readings may occur.

Plug the unit into the safety analyzer, and plug the power cord of the safety analyzer into a 115 V receptacle.

6.1.1.2 Set the safety analyzer function switch to the "GROUND WIRE RESISTANCE" position. Attach the test lead to the "SINGLE LEAD" connector.

6.1.1.3 Set the safety analyzer "GROUND" switch to the "NORMAL" position. Set the "POLARITY" switch to the "OFF" position.

6.1.1.4 The safety analyzer shall indicate 0.1 ohms or less with its test lead applied to the following points:

--Cylinder yoke
--Blood pressure pump mounting bracket (inside monitor chassis)

### 6.1.2 Circuit Isolation Test

6.1.2.1 Apply the safety analyzer and check for continuity between the monitor box chassis and the circuit common at backplane connector J29, Pin 13. There shall be no continuity between these points.

6.1.3 Chassis Leakage Current Test

6.1.3.1 Turn the NM4 System Power switch to ON and set the safety analyzer to the "CHASSIS LEAKAGE CURRENT" position.

6.1.3.2 Attach the safety analyzer test lead to a yoke assembly.

6.1.3.3 Record the total leakage current with the polarity and ground switches set to the following positions:

| Ground | Polarity |
|---|---|
| Open | Normal |
| Normal | Normal |
| Open | Reversed |
| Normal | Reversed |

Verify that the leakage current is 75 microamps* or less in each of the positions (110 microamps or less for 220/240 volt power supply option).

* 100 microamps if external monitors are plugged into convenience outlets.

## 6.2 Battery Circuit Test

6.2.1 Is "ON" LED lighted? __ (Y)

6.2.2 With the System Power switch ON, unplug the AC power cord.

6.2.3 Is yellow "AC PWR FAIL" LED lighted as long as the power cord is unplugged? __ (Y)

6.2.4 Does the "AC PWR FAIL" message appear in the Advisory display? __ (Y)

6.2.5 Press and hold the "BATTERY TEST" button.

6.2.6 Is green Battery Test LED lighted as long as "BATTERY TEST" button is depressed? __ (Y)

6.2.7 Release the "BATTERY TEST" button.

6.2.8 Restore AC power to the machine.

## 6.3 Manual Sphygmomanometer

6.3.1 Insert the male Luer fitting of the Sphygmomanometer squeeze bulb-hose assembly into the female Luer fitting adjacent to the BLOOD PRESSURE label on the machine.

6.3.2 Wrap the blood pressure cuff around an "E" cylinder.

6.3.3 Hand pump the squeeze bulb until pressure of 200 mm Hg is indicated on the Sphygmomanometer gauge on the machine. Pinch the hose adjacent to the Luer fitting to assure that the hose-bulb is not the source of any leak.

6.3.4 After thirty (30) seconds, what is the pressure on the Sphygmomanometer gauge? ___ mm Hg (190-200)

6.3.5 Bleed the pressure.

6.3.6 The Sphygmomanometer should indicate within the band.

6.3.7 Attach a test Sphygmomanometer in series with the gauge being tested.

6.3.8 Hand pump the squeeze bulb until the machine gauge indicates 100mm Hg.

6.3.9 What does the test gauge indicate? ___ mm Hg (90-110).

6.3.10 Hand pump the squeeze bulb until the machine gauge indicates 200mm Hg.

6.3.11 What does the test gauge indicate? ___ mm Hg (180-220).

6.3.12 Hand pump the squeeze bulb until the machine gauge indicates 300mm Hg.

6.3.13 What does the test gauge indicate? ___ mm Hg (> 290).

6.3.14 Remove the test gauge.

6.3.15 Remove the blood pressure cuff from the "E" cylinder.

6.3.16 Record the Sphygmomanometer serial number on the check list.

## 6.4 Vapor Exclusion System and Agent Indicator Lamp Test

6.4.1 Set all vapors to zero (0).

6.4.2 Adjust the handwheel on the left position vapor to any concentration above zero (0).

6.4.3 Verify that only the correctly labeled indicator lamp above the left vaporizer illuminates during full rotation of the hand wheel.

6.4.4 Allow the "CO2 CALIBRATION IN PROGRESS" to complete on the remote display.

6.4.5 Verify that the correct abbreviation for the agent selected appears on the display.

6.4.6 Is it possible to turn on the center position vapor?___(N)

6.4.7 Is it possible to turn on the right position vapor?___(N)

6.4.8 Set the handwheel on the left position vapor to zero (0).

6.4.9 Adjust the handwheel on the center position vapor to any concentration above zero (0).

6.4.10 Verify that only the correctly labeled indicator lamp above the center vaporizer illuminates during full rotation of the hand wheel.

6.4.11 Allow the "CO2 CALIBRATION IN PROGRESS" to complete on the remote display.

6.4.12 Verify that the correct abbreviation for the agent selected appears on the display.

6.4.13 Is it possible to adjust the left position vapor? ___ (N)

6.4.14 Is it possible to adjust the right position vapor? ___ (N)

6.4.15 Set the handwheel on the center position vapor to zero (0).

6.4.16 Adjust the handwheel on the right position vapor to any concentration above zero (0).

6.4.17 Verify that only the correctly labeled indicator lamp above the right vaporizer illuminates during full rotation of the hand wheel.

6.4.18 Allow the "CO2 CALIBRATION IN PROGRESS" to complete on the remote display.

6.4.19 Verify that the correct abbreviation for the agent selected appears on the display.

6.4.20 Is it possible to adjust the left position vapor? ___ (N)

6.4.21 Is it possible to adjust the center position vapor? ___ (N)

6.4.22 Set the handwheel on the right position vapor to zero (0).

6.4.23 Verify that all vaporizer indicator lamps are off.

## 6.5 High Pressure Leak Test

Before performing this test, ensure that cylinder pressures are: N2O & CO2: 600 psi; O2, Air, He, He/O2, N2: 1000 psi.
Set cylinder regulators at: N2O: 40 - 49 psi; O2 and Air: 43 - 49 psi.

### 6.5.1 Yoke Verification

6.5.1.1 Turn the System Power switch to STANDBY, and close all cylinder valves.

6.5.1.2 Disconnect the pipeline supply hoses at the wall outlets.

6.5.1.3 Remove the closed cylinder or yoke plug from each yoke assembly.

6.5.1.4 Do all the yoke handles adjust smoothly? ___ (Y)

6.5.1.5 Are the two (2) yoke pins installed securely in each yoke? ___ (Y)

6.5.1.6 Is there only one (1) cylinder washer on each yoke assembly? ___ (Y)

6.5.1.7 Is there a yoke plug attach to each yoke assembly? ___ (Y)

6.5.1.8 Is the proper gas identification label affixed to each yoke assembly? ___ (Y)

6.5.1.9 Attach a cylinder to each yoke assembly, open the cylinder valve, let the pressure stabilize, close the cylinder valve, remove the cylinder from the yoke assembly.

6.5.1.10 Does the yoke check valve assembly prevent the escape of excessive pressure? ___ (Y)

6.5.1.11 Attach the cylinders to the yokes.

### 6.5.2 Nitrous Oxide High Pressure Leak Test

6.5.2.1 Open one (1) oxygen cylinder valve and one (1) nitrous oxide cylinder valve.

6.5.2.2 Let the pressure stabilize.

6.5.2.3 Close the nitrous oxide cylinder valve and remove the cylinder.

6.5.2.4 Observe the nitrous oxide cylinder pressure gauge.

6.5.2.5 After two (2) minutes, what is the pressure loss? ___ PSI (<50)

6.5.2.6 Attach the cylinder.

### 6.5.3 Oxygen High Pressure Leak Test

6.5.3.1 Open one (1) oxygen cylinder valve.

6.5.3.2 Let the pressure stabilize.

6.5.3.3 Close the oxygen cylinder valve and remove the cylinder.

6.5.3.4 Observe the oxygen cylinder pressure gauge.

6.5.3.5 After two (2) minutes, what is the pressure loss? ___ PSI (<50)

6.5.3.6 Attach the cylinder.

### 6.5.4 Air High Pressure Leak Test - If Applicable

6.5.4.1 Open the air cylinder valve.

6.5.4.2 Let the pressure stabilize.

6.5.4.3 Close the air cylinder valve and remove the cylinder.

6.5.4.4 Observe the air cylinder pressure gauge.

6.5.4.5 After two (2) minutes, what is the pressure loss? ___ PSI (<50)

6.5.4.6 Attach the air cylinder.

6.5.5 Oxygen-Helium High Pressure Leak Test - If Applicable

6.5.5.1 Open the oxygen-helium cylinder valve.

6.5.5.2 Let the pressure stabilize.

6.5.5.3 Close the oxygen-helium cylinder valve and remove the cylinder.

6.5.5.4 Observe the oxygen-helium cylinder pressure gauge.

6.5.5.5 After two (2) minutes, what is the pressure loss? ___ PSI (<50)

6.5.5.6 Attach the oxygen-helium cylinder.

## 6.6 Oxygen Supply Failure Protection

6.6.1 Nitrous Oxide O.F.P. Device

6.6.1.1 Turn the System Power switch to "ON".

6.6.1.2 Open and close the oxygen cylinder valve.

6.6.1.3 Open the nitrous oxide cylinder valve.

6.6.1.4 Adjust the $O_2$ and $N_2O$ flow to 4 l/min.

6.6.1.5 Does the flow of nitrous oxide cease when the oxygen pressure is depleted? ___ (Y)

6.6.1.6 Close the $N_2O$ cylinder valve and bleed the pressure from the circuit.

6.6.1.7 Connect the $N_2O$ pipeline hose to the wall outlet.

6.6.1.8 Close the $O_2$ pipeline supply.

6.6.1.9 Does the flow of nitrous oxide cease when the oxygen pressure is depleted? ___ (Y)

6.6.1.10 Close the nitrous oxide flow control valve.

6.6.2 Air O.F.P. Device - If Applicable

* 6.6.2.1 Set the LOCK OUT device to "ALL GASES".

6.6.2.2 Open the oxygen cylinder valve.

* These items do not apply to machines with later design (P/N 4113229) ORC.

6.6.2.3 Open the air cylinder valve.

6.6.2.4 Set the air flow to 4 l/min; set the oxygen flow to 4 l/min.

6.6.2.5 Close the oxygen cylinder valve.

6.6.2.6 Does the flow of air cease when the $O_2$ pressure is depleted? ___ (Y)

6.6.2.7 Close the air flow control valve.

* 6.6.2.8 Set the LOCK OUT device to "$O_2$+$N_2O$".

### 6.6.3 Oxygen-Helium O.F.P. Device - If Applicable

* 6.6.3.1 Set the LOCK OUT device to "ALL GASES".

6.6.3.2 Open the oxygen-helium cylinder valve.

6.6.3.3 Open one (1) oxygen cylinder valve.

6.6.3.4 Set the oxygen-helium flow to 4 l/min; set the oxygen flow to 4 l/min.

6.6.3.5 Close the oxygen cylinder valve.

6.6.3.6 Does the flow of oxygen-helium cease when the oxygen pressure is depleted? ___ (Y)

6.6.3.7 Close the oxygen-helium flow control valve.

### 6.6.4 Oxygen Supply Pressure Alarm

6.6.4.1 Remove the table top.

6.6.4.2 Remove the plug from the tee fitting on the $O_2$ regulator output line and connect a test gauge.

6.6.4.3 Open and close the oxygen cylinder valve.

6.6.4.4 Set the oxygen flow to 2 l/min.

6.6.4.5 What is the pressure on the test gauge when the "O2 SUPPLY PRESSURE" LED turns on? ___ PSI (34-40)

6.6.4.6 Does the "LO $O_2$ SUPPLY" message appear in the CAUTION column? ___ (Y)

* These items do not apply to machines with later design (P/N 4113229) ORC.

## 6.7 Flowmeter Test

### 6.7.1 Oxygen Flowmeter Test

6.7.1.1 Open the oxygen cylinder valve.

6.7.1.2 Is it possible to adjust the flow of oxygen over the full range of the flowmeters? ___ (Y)

6.7.1.3 Close the $O_2$ cylinder valve and bleed the pressure from the system.

6.7.1.4 Connect the $O_2$ pipeline hose.

6.7.1.5 Is it possible to adjust the flow of oxygen over the full range of the flowmeters? ___ (Y)

6.7.1.6 Is the correct flow control knob and label attached to the oxygen flow control valve? ___ (Y)

6.7.1.7 Close the oxygen flow control valve.

6.7.1.8 What is the minimum flow of oxygen? ___ ml (125-175) ml/min (150-200 for machines with later design (P/N 4113229) ORC). *(0 ml for 4107615A (Minimum $O_2$ Flow Elimination))

### 6.7.2 Nitrous Oxide Flowmeter Test

6.7.2.1 Set the oxygen flow to 4 l/min.

6.7.2.2 Open the nitrous oxide cylinder valve.

6.7.2.3 Is it possible to adjust the flow of nitrous oxide over the full range of the flowmeter? ___ (Y)

6.7.2.4 Close the nitrous oxide cylinder valve and bleed the pressure from the system.

6.7.2.5 Connect the $N_2O$ pipeline hose.

6.7.2.6 Is it possible to adjust the flow of nitrous oxide over the full range of the flowmeters? ___ (Y)

* These items do not apply to machines with later design (P/N 4113229) ORC.

6.7.2.7 Is the correct flow control knob and label attach to the $N_2O$ flow control valve? ___ (Y)

6.7.2.8 Close the oxygen and nitrous oxide flow control valves.

### 6.7.3 Air Flowmeter Test - If Applicable

* 6.7.3.1 Set the LOCK OUT device to "ALL GASES".

6.7.3.2 Open the air cylinder valve.

6.7.3.3 Is it possible to adjust the flow of the air over the full range of the flowmeter? ___ (Y)

6.7.3.4 Close the air flow control valve.

6.7.3.5 Is the correct flow control knob and label attached to the air flow control valve? ___ (Y)

* 6.7.3.6 What is the minimum flow of oxygen? ___ ml (0)

* 6.7.3.7 Set the LOCK OUT device to "$O_2$+$N_2O$".

### 6.7.4 Oxygen-Helium Flowmeter Test - If Applicable

* 6.7.4.1 Set the LOCK OUT device to "ALL GASES".

6.7.4.2 Open the oxygen-helium gas cylinder valve.

6.7.4.3 Is it possible to adjust the flow of the oxygen-helium over the full range of the flowmeter? ___ (Y)

6.7.4.4 Close the oxygen-helium flow control valve.

6.7.4.5 Is the correct flow control knob and label attach to the oxygen-helium flow control valve? ___ (Y)

* 6.7.4.6 Set the LOCK OUT device to "$O_2$+$N_2O$".

* These items do not apply to machines with later design (P/N 4113229) ORC.

6.7.5 Auxiliary Oxygen Flowmeter Test

6.7.5.1 Connect a test cm $H_2O$ gauge to the outlet.

6.7.5.2 Bleed any pressure from the system.

6.7.5.3 Is there an increase in pressure? ___ (N)

6.7.5.4 Increase the pressure to 50 cm $H_2O$.

6.7.5.5 After 30 seconds, what is the pressure ___ cm $H_2O$ (30-50)

6.7.5.6 Remove the test gauge.

6.7.5.7 Is it possible to adjust the flow over the full range of the flowmeter? ___ (Y)

6.7.5.8 Set the flow rate to 5 l/min.

6.7.5.9 Hold the sensor from a calibrated $O_2$Med at the flowmeter outlet.

6.7.5.10 What is the oxygen concentration? ___ % (97-100)

6.7.5.11 Remove the $O_2$Med sensor.

6.7.5.12 Close the flowmeter flow control valve.

## 6.8 NAD O2 Monitor

6.8.1 Disconnect the $O_2$ sensor cord at the VPO panel. The Advisory messages "$O_2$ SENSOR DISC" and "$O_2$ NOT CAL" shall appear on the central alarm display, and a single-tone audible alarm shall sound.

6.8.2 Reconnect the $O_2$ Med sensor.

6.8.3 Touch "$O_2$ CAL" box. **NOTE: Make sure the sensor is exposed to only 21% $O_2$ (room air).**

6.8.4 After the calibration is completed, what is the displayed oxygen concentration? ___% (21)

NOTE: Set system alarms to factory defauts.

6.8.5 The Warning message "INSP $O_2$ LOW" shall appear on the central alarm display, and a continuous audible alarm shall sound.

6.8.6 What is the oxygen LO alarm default? ___ (30)

6.8.7 Touch the oxygen LO alarm box. Does the box illuminate? ___ (Y)

6.8.8 Verify that the oxygen LO alarm limit has a range from 18 to 99%.

6.8.9 Set the LO limit to 18.

6.8.10 Touch the oxygen HI alarm box. Does the box illuminate? ___ (Y)

6.8.11 What is the HI oxygen alarm default? ___ (100)

6.8.12 Verify that the oxygen HI alarm limit has a range from 100 to 19%.

6.8.13 Set the HI limit to 19.

6.8.14 Expose the $O_2$ Med sensor to room air (21% $O_2$).

6.8.15 The Advisory message "INSP $O_2$ HIGH" shall appear on the central alarm display, and a single-tone audible alarm shall sound.

6.8.16 Adjust the HI limit to 51%.

6.8.17 The "INSP $O_2$ HIGH message shall be extinguished.

6.8.18 Return the HI limit to 100.

6.8.19 Place the sensor into the valve dome, set the oxygen flow to 10 l/min., set the Man/Auto to BAG, close the APL valve, attach a 12 inch hose to the inspiratory valve and occlude the bag mount.

6.8.20 After 3 minutes, what is the oxygen concentration? ___%(97-100)

6.8.21 Close the oxygen flow control valve.

## 6.9 Oxygen Concentration Tests

### 6.9.1 Oxygen + Nitrous Oxide Concentration Test

6.9.1.1 Turn the System Power switch to ON.

6.9.1.2 Connect a 12 inch hose to the inspiratory valve.

6.9.1.3 Set the Manual/Automatic to BAG.

6.9.1.4 Close the APL valve.

6.9.1.5 Occlude the bag mount.

6.9.1.6 Insert the sensor from a calibrated $O_2$ Med into the valve dome adapter on the inspiratory valve.

6.9.1.7 Close all the flow control valves.

6.9.1.8 Open one (1) cylinder valve for each gas.

6.9.1.9 Depress the "$O_2$ FLUSH" for 15 seconds.

6.9.1.10 Set the oxygen flow to 4 l/min.

6.9.1.11 Does the $O_2$ Med read 97-100% within 3 minutes? ___ (Y)

6.9.1.12 Set the nitrous oxide flow to 2 l/min.

6.9.1.13 What is the oxygen concentration? ___ % (64-70)

6.9.1.14 Set the nitrous oxide flow to 4 l/min.

6.9.1.15 What is the oxygen concentration? ___% (47-53)

6.9.1.16 Close all flow control valves.

### 6.9.2 Oxygen + Air Concentration Test - If Applicable

6.9.2.1 Depress the "$O_2$ FLUSH" for 15 seconds.

6.9.2.2 Does the $O_2$ Med read 97-100% within 3 minutes? ___ (Y)

* 6.9.2.3 Set the LOCK OUT device to "ALL GASES".

6.9.2.4 Set the oxygen flow to 4 l/min.

* These items do not apply to machines with later design (P/N 4113229) ORC.

6.9.2.5 Set the air flow to 2 l/min.

6.9.2.6 What is the oxygen concentration? ___ % (71-77)

6.9.2.7 Close the air flow valve.

* 6.9.2.8 Set the LOCK OUT device to "$O_2$+$N_2O$".

6.9.3 Oxygen + Helium and Oxygen Concentration Test - If Applicable

6.9.3.1 Depress the "$O_2$ FLUSH" for 15 seconds.

6.9.3.2 Does the $O_2$ Med read 97-100% within 3 minutes? ___ (Y)

* 6.9.3.3 Set the LOCK OUT device to "ALL GASES".

6.9.3.4 Set the oxygen flow to 4 l/min.

6.9.3.5 Set the oxygen-helium flow to 2 l/min.

6.9.3.6 What is the oxygen concentration? ___ % (72-78)

6.9.3.7 Close the oxygen-helium flow control valve.

* 6.9.3.8 Set the LOCK OUT device to "$O_2$+$N_2O$".

6.9.4 Oxygen + Carbon Dioxide Concentration Test - If Applicable

* 6.9.4.1 Set the gas selector switch to ALL GASES.

6.9.4.2 Depress the $O_2$FLUSH button for 15 seconds.

6.9.4.3 Does the $O_2$MED read 97-100% within 3 minutes?___ (Y)

6.9.4.4 Set the oxygen flow to 1000 ml/min.

6.9.4.5 Set the carbon dioxide flow to 500 ml/min.

6.9.4.6 What is the oxygen concentration? ___ % (64-70)

6.9.4.7 Close the carbon dioxide flow control valve.

6.9.4.8 Close the oxygen flow control valve.

* 6.9.4.9 Set the gas selector switch to $O_2$+$N_2O$.

* These items do not apply to machines with later design (P/N 4113229) ORC.

## 6.10 Gauges

### 6.10.1 Cylinder Gauges

6.10.1.1 Are the pressure gauges correct for the gases indicated by the flowmeters and yoke assemblies? ___ (Y)

6.10.1.2 Are the gauges closest to the table top for cylinder supply pressure? ___ (Y)

6.10.1.3 Bleed all the pressure from the cylinder circuit.

6.10.1.4 Are the cylinder gauges at zero "0" PSI? ___ (Y)

6.10.1.5 Open the cylinder valves.

6.10.1.6 Do the cylinder pressure gauges respond properly? ___ (Y)

6.10.1.7 Close the cylinder valves.

6.10.1.8 Bleed all pressure from the cylinder circuits.

### 6.10.2 Pipeline Gauges

6.10.2.1 Are the pipeline gauges right below the flowmeters for pipeline supply pressure? ___ (Y)

6.10.2.2 Are the pipeline pressure gauges at "0" PSI? ___ (Y)

6.10.2.3 Connect the pipeline supply.

6.10.2.4 Do the pipeline pressure gauges respond properly? ___ (Y)

6.10.2.5 Are the correct gas identification labels affixed at each of the pipeline inlets? ___ (Y)

6.10.2.6 Does the back panel identify each of the pipeline inlets properly? ___ (Y)

## 6.11 Freshgas Leak Test

6.11.1 Turn the System Power switch to STANDBY.

6.11.2 Remove the 15 mm connector from the FRESHGAS OUTLET.

6.11.3 Is the common gas outlet assembly in good condition? ___ (Y)

6.11.4 Connect a digital pressure manometer and Fresh Gas Leak Test Device to the freshgas outlet.

6.11.5 Apply 50 cm $H_2O$ of pressure to the system.

6.11.6 After thirty (30) seconds, what is the pressure on the manometer? ___ (>40 cm $H_2O$)

6.11.7 Turn on the left mounted vaporizer to the first graduated marking.

6.11.8 Apply 50 cm $H_2O$ of pressure to the system.

6.11.9 After thirty (30) seconds, what is the pressure on the manometer? ___ (>40 cm $H_2O$)

6.11.10 Turn off the vaporizer.

6.11.11 Remove the test equipment from the Fresh Gas Outlet.

6.11.12 Turn the System Power switch to ON.

6.11.13 Open the $O_2$ flow control valve to 5 l/min., purge the system for 5 seconds, then close the $O_2$ flow control valve.

6.11.14 Turn the System Power switch to STANDBY.

6.11.15 Turn on the center mounted vaporizer to the first graduated marking, repeat Steps 6.11.4 and 6.11.8 thru 6.11.14. ___ (>40 cm $H_2O$)

6.11.16 Turn on the right mounted vaporizer to the first graduated marking, repeat Steps 6.11.4 and 6.11.8 thru 6.11.14. ___ (>40 cm $H_2O$)

6.11.17 Remove the manometer and Fresh Gas Leak Test Device.

6.11.18 Reconnect the 15 mm connector from the absorber system to the FRESHGAS OUTLET.

6.11.19 Is the FRESHGAS OUTLET label on the freshgas outlet? ___ (Y)

## 6.12 Absorber System

### 6.12.1 Repack MAN/AUTO Selector Valve S/N _____

[Does not apply to machines with later design selector valve.]

6.12.1.1 Remove the four screws securing the stick shift block to the selector valve body and remove the block.

6.12.1.2 Remove the spring and valve channel from the valve body.

6.12.1.3 Remove all residual lubricant from the valve channel.

6.12.1.4 Remove all residual lubricant from the valve body.

6.12.1.5 Apply a minimal amount of "stop cock" lubricant to the tapered surface of the valve channel, and ensure complete coverage of lubricant.

6.12.1.6 Insert the valve channel into the valve body.

6.12.1.7 Insert the spring into the stick shift block.

6.12.1.8 Align the index pins on the stick shift block to the holes in the valve channel.

6.12.1.9 Secure the stick shift block to the selector valve body with the four screws that were previously removed.

6.12.2 Lubrication, Spiromed Sensor S/N _____

6.12.2.1 Remove the expiratory valve.

6.12.2.2 Remove the Spiromed Sensor.

6.12.2.3 Locate the four lateral holes at the sides of the Spiromed sensor marked by printed arrows.

CAUTION: Use only Sensor Lubrication Kit P/N 2218180 or sensor lubricant P/N S010104 for the following procedure.

6.12.2.4 Remove the protective cover from the pipette and open the lubricant bottle.

6.12.2.5 Dip the tip of the pipette into the lubricant and draw one drop of lubricant into the pipette by pulling the pin upwards.

6.12.2.6 Insert the pipette into one of the four holes as far as it will go. Push the pin forward to its stop to inject lubricant into the hole.

6.12.2.7 Repeat the procedure on the three remaining holes.

6.12.2.8 Wipe any lubricant residue from the exterior of the sensor.

6.12.2.9 Reattach the sensor to the absorber top dome.

6.12.2.10 Reattach the expiratory valve to the sensor.

6.12.3 Absorber System Inspection S/N _____

6.12.3.1 Remove the inspiratory and the expiratory valve domes.

6.12.3.2 Is there a broken or bent pin on the valve assembly
Inspiratory? ___ (N) Expiratory? ___ (N)

6.12.3.3 Is there a broken pin on the valve domes
Inspiratory? ___ (N) Expiratory? ___ (N)

6.12.3.4 Is the valve disc in good condition
Inspiratory? ___ (Y) Expiratory? ___ (Y)

6.12.3.5 Are the valve dome washers in good condition? ___ (Y)

6.12.3.6 Reinstall the inspiratory and expiratory valve domes.

6.12.3.6A Remove the ultrasonic flow sensor connector hose - if applicable.

6.12.3.6B Is the connector hose, connector, and O-ring in good condition? ___(Y) - if applicable.

6.12.3.6C Remove the ultrasonic flow sensor from the mounting bracket - if applicable.

6.12.3.6D Remove the flow housing/transducer assembly from the electronics housing - if applicable.

6.12.3.6E Remove both transducers from the flow housing; examine each O-ring and condition of all components, then reassemble - if applicable.

6.12.3.7 Remove the inspiratory and expiratory valve assemblies.

6.12.3.8 Remove the Spiromed sensor.

6.12.3.9 Are all three washers in good condition? ___ (Y)

6.12.3.10 Reinstall the Spiromed sensor - if applicable, and the inspiratory valve.

6.12.3.11 Reinstall the expiratory valve and the connector hose between the expiratory valve and the ultrasonic flow sensor - if applicable.

6.12.3.12 Are there two (2) spring clips on the absorber rods?___ (Y)

6.12.3.13 Inspect the following: Canisters and Gaskets, Dust Cup and O-ring, condition of soda lime

6.12.3.14 Is the cm $H_2O$ gauge at zero (0)? ___ (Y)

6.12.3.15 Check for proper seating of the O-ring at the gauge mount.

6.12.3.16 Remove the $O_2$Med sensor plug from the inspiratory valve dome adapter and examine the two O-rings at the bottom of the plug.

6.12.3.17 Uncap the $O_2$Med sensor and examine the two O-rings at the bottom of the sensor.

6.12.3.18 Reinstall the $O_2$Med sensor into the inspiratory valve dome adapter.

### 6.12.4 Breathing System Leak Test

6.12.4.1 Short circuit the inspiratory and expiratory valves with a 12 inch hose.

6.12.4.2 Attach a test terminal with a cuff inflation bulb to the bag mount.

6.12.4.3 Set the Man/Auto selector valve to BAG.

6.12.4.4 Close the APL valve.

6.12.4.5 Presssurize the absorber system to 50 cm $H_2O$.

6.12.4.6 After 30 seconds, what is the pressure in the absorber system? ___ cm $H_2O$ ($\geq$30)

### 6.12.5 APL Valve Test

6.12.5.1 Open the APL valve to its stop.

6.12.5.2 Turn the System Power switch to ON.

6.12.5.3 Set the oxygen flow to 8 l/min.

6.12.5.4 What is the pressure on the absorber pressure gauge? ___ cm $H_2O$ ($\leq$3)

6.12.5.5 Close the oxygen flow control valve.

6.12.5.6 Turn the System Power switch to STANDBY.

6.12.5.7 Remove the test terminal and cuff inflation bulb from the bag connector.

### 6.12.6 Absorber Flow Direction and Leak Test

#### 6.12.6.1 Expiration Valve Leak Test

6.12.6.1.1 Close the APL valve.

6.12.6.1.2 Connect a 22mm hose between the inspiration valve and the bag mount.

6.12.6.1.3 Connect a test terminal to the expiration valve or the expiratory hose terminal on the ultrasonic flow sensor, if applicable.

6.12.6.1.4 Connect a Capnomed flowmeter to the test terminal.

6.12.6.1.5 Turn the System Power switch to ON, turn up the oxgen flow until the system pressurizes to 30 $cmH_2O$.

6.12.6.1.6 Verify that the value indicated on the flowmeter is ≤60ml/min.

6.12.6.1.7 Turn the System Power switch to STANDBY and remove all test equipment.

#### 6.12.6.2 Inspiratory valve leak test

6.12.6.2.1 Connect a test terminal to the inspiratory valve.

6.12.6.2.2 Connect a tee adapter and calibrated pressure meter to the test terminal.

6.12.6.2.3 Connect a pressure bulb to the open port of the tee adapter.

6.12.6.2.4 Connect another test terminal to the bag connector.

6.12.6.2.5 Connect a Capnomed flowmeter to the test terminal on the bag mount.

6.12.6.2.6 Pressurize the system to 30 $cmH_2O$.

6.12.6.2.7 Verify that the flow meter indicates ≤60 ml/min.

6.12.6.2.8 Remove all test equipment.

6.12.6.2.9 Open the APL valve.

6.12.6.3 Flow Direction Test

6.12.6.3.1 Attach a breathing circuit with a 3-liter bag at the Y-piece to the inspiration and expiration valve or the expiratory hose terminal on the ultrasonic flow sensor, if applicable.

6.12.6.3.2 Attach a 3-liter bag to the swivel bag mount.

6.12.6.3.3 Turn the System Power switch to ON and set the $O_2$ flow to 4 l/min.

6.12.6.3.4 Inflate the simulated lung by briefly using the $O_2$ Flush.

6.12.6.3.5 Partially close the APL valve.

6.12.6.3.6 Squeeze the breathing bag attached to the bag mount at a rate of approximately 10 BPM. Readjust the APL valve if required to properly ventilate the simulated lung.

6.12.6.3.7 Observe the operation of each unidirectional valve disc at eye level and make sure the inspiratory valve disc raises only during the inspiration phase, and the expiratory valve raises only during the exhalation phase. Watch the valves until satisfied that both valves operate correctly, and move freely without sticking.

6.12.6.3.8 Open the APL valve.

6.12.7 PEEP Bypass Valve - If applicable. S/N _____

6.12.7.1 Set the $O_2$ flow to 5 l/min.

6.12.7.2 Adjust the PEEP valve clockwise to the maximum position.

6.12.7.3 Raise the bypass valve to the "PEEP ON" position.

6.12.7.4 What is the maximum PEEP? ___ cm $H_2O$ (15-22 cm $H_2O$).

6.12.7.5 Does the PEEP valve adjust smoothly? ___ (Y)

6.12.7.6 Adjust the PEEP valve counter-clockwise to its minimum position.

6.12.7.7 What is the minimum PEEP? ___ cm $H_2O$ (2-3 cm $H_2O$).

6.12.7.8 Adjust the PEEP valve clockwise to its maximum position.

6.12.7.9 Lower the bypass valve to the "PEEP OFF" position.

6.12.7.10 What is the maximum PEEP? ___ cm $H_2O$ (2-3 cm $H_2O$)

6.12.7.11 Adjust the PEEP valve counter-clockwise to its minimum position.

6.12.7.12 Close the $O_2$ flow control valve.

## 6.13 Ventilator Test

### 6.13.1 Ventilator

NOTE: Set the Pressure Limit control to MAX, and the PEEP valve to the minimum position, if applicable. Readjustment of INSPIRATORY FLOW to limit the inspiritory plateau may be required to reduce erratic tidal volumes and breath rates caused by artifact volume.

** 6.13.1.1 Set the Man/Auto selector to BAG.

6.13.1.2 Set the FREQUENCY to 10 BPM.

6.13.1.3 Set the I:E Ratio to 1:2.

6.13.1.4 Set the Tidal Volume to 1000 ml.

6.13.1.5 Attach a patient circuit to the absorber system.

6.13.1.6 Adjust the $O_2$ flow to 3 l/min.

6.13.1.7 Is the APNEA-P OFF message displayed in the Advisory column? (Y) (if no, touch "APNEA ALARM ON")

6.13.1.8 Is the VOL-ALARMS OFF message displayed in the Advisory column? (Y) (if no, touch "VOLUME ALARM ON")

6.13.1.9 Turn the ventilator on.

** 6.13.1.10 Verify the FAULT indicator turns on (Y)

6.13.1.11 Set the Man/Auto selector switch to AUTO.

** 6.13.1.12 Verify the FAULT indicator turns off (Y)

6.13.1.13 Do the APNEA-P ALARM OFF and VOL-ALARMS OFF messages disappear from the Advisory column? (Y)

6.13.1.14 Adjust the INSPIRATORY FLOW to the maximum of the LOW zone.

6.13.1.15 Occlude the Y-piece with your thumb.

** These items only apply to machines with an AV2+ ventilator.

6.13.1.16 Inflate the bellows by momentarily pressing the $O_2$ Flush.

6.13.1.17 What is the peak inspiratory pressure? ___ cm $H_2O$ (>30 cm $H_2O$)

### 6.13.2 I:E Ratio and Frequency Test

6.13.2.1 Attach a test 3-liter bag to the Y-piece.

6.13.2.2 Using a stopwatch, time the inspiratory phase.

6.13.2.3 What is the inspiratory time? ___ seconds (1.8 - 2.2)

6.13.2.4 Using a stopwatch, time the expiratory phase.

6.13.2.5 What is the expiratory time? ___ seconds (3.6 - 4.4)

** 6.13.2.6 Press and hold the EXTENDED RANGE switch and scroll the I:E ratio dial counter clockwise and verify the extended I:E ratio values increment (2:1, 3:1 and 4:1); return the I:E ratio to 2:1.

** 6.13.2.7 Using a stopwatch time the inspiratory phase.

** 6.13.2.8 What is the inspiratory time? ___ seconds (3.6 - 4.4)

** 6.13.2.9 Using a stopwatch, time the expiratory phase.

** 6.13.2.10 What is the expiratory time? ___ seconds (1.8 - 2.2)

6.13.2.11 Adjust the frequency and I:E Ratio through the following settings and verify that the ventilator cycles properly:

| FREQ. | I:E RATIO | FREQ. | I:E RATIO |
|---|---|---|---|
| 11 | 1:1 | 66 | 1:3.5 |
| 22 | 1:1.5 | 77 | 1:4 |
| 33 | 1:2 | 88 | 1:4.5 |
| 44 | 1:2.5 | 99 | 1:4.5 |
| 55 | 1:3 | | |

** These items apply to machines with an AV2+ ventilator.

## 6.14 Bellows Drive Gas Leak Test

6.14.1 Remove the ventilator hose from the bellows assembly.

6.14.2 Attach a test terminal to the bellows assembly.

6.14.3 Attach a Capnomed flowmeter test stand to the test terminal.

6.14.4 Set the BPM to 1.

6.14.5 Set the I:E Ratio to 1:1.

6.14.6 Set the flow to the maximum.

6.14.7 What is the volume that is registered during the inspiratory plateau phase? ___(<50 ml)

6.14.8 Remove the test terminal and flowmeter test stand. Connect the ventilator hose to the VENTILATOR HOSE terminal.

## 6.15 "F" Bellows Test S/N _____

6.15.1 Insert a calibrated volumeter between the absorber dome and the expiratory valve, and set the BPM to 10.

6.15.2 Set the I:E Ratio to 1:2.

6.15.3 Adjust the $O_2$ flow to 300 ml.

6.15.4 Adjust the inspiratory flow to "MED".

6.15.5 Adjust the Tidal Volume to 200 ml.

6.15.6 What is the Tidal Volume on the test volumeter? ___ ml (125-250 ml

6.15.7 Adjust the Tidal Volume to 1000 ml.

6.15.8 What is the Tidal Volume on the test volumeter? ___ ml (900-1100 ml)

6.15.9 Adjust the inspiratory flow to "HIGH".

6.15.10 Adjust the $O_2$ flow to 5 l/min.

6.15.11 this step intentionally left blank.

6.15.12 Adjust the Tidal Volume to maximum.

6.15.12A Remove the test lung and attach a 3 liter breathing bag.

6.15.12B Adjust the Inspiratory Flow to fully compress the bellows.

NOTE: The bag should be placed on a flat horizontal surface to reduce artifact volume.

6.15.13 What is the Tidal Volume on the test volumeter? ___ ml (≥1400)

## 6.16 Pressure Limit Control Test - If Applicable

6.16.1 Set the Inspiratory Flow to the bottom of the LOW range.

6.16.2 Set the oxygen flow rate to 4 l/min.

6.16.3 Set the pressure limit control to the MAX position.

6.16.4 Occlude the Y-piece with your thumb.

6.16.5 Slowly increase the Inspiratory Flow setting until a peak pressure of 80 cm $H_2O$ is achieved.

6.16.6 Set the pressure limit control to 30.

6.16.7 What is the peak pressure? ___ cm $H_2O$ (27-33)

6.16.8 Set the pressure limit control to the MIN position.

6.16.9 What is the peak pressure? cm $H_2O$ (9-15)

6.16.10 Remove your thumb from the Y-piece.

6.16.11 Set the inspiratory flow to the maximum of the LOW zone.

6.16.12 Turn the ventilator OFF.

NOTE: The inspiratory flow gauge will not return to the stop position when the ventilator is turned off.

## 6.17 Ventilator Relief Valve Test

6.17.1 Adjust the $O_2$ flow to 10 l/min.

6.17.1A Adjust the inspiratory flow to fully compress the bellows.

6.17.2 Adjust the inspiratory flow to "MED".

6.17.3 Adjust the I:E Ratio to 1:3.

6.17.4 Adjust the Tidal Volume to 1200 ml.

6.17.5 What is the PEEP? ___ cm $H_2O$ (≤3 cm $H_2O$)

6.17.6 Adjust the $O_2$ flow to 500 ml.

6.17.7 What is the Tidal Volume on the test volumeter? ___ml (1080-1320)

6.17.8 Does the bellows stop adjust smoothly? ___ (Y)

## 6.18 SPIROMED or Ultrasonic Flow Sensor Test

6.18.1 Touch the MONITOR SET UP key. Does the box illuminate the "MIN VOL" alarm limit? ___ (Y)

6.18.2 What is the "LO" MIN VOL alarm default? ___ (1.0)

6.18.3 Verify that the MIN VOL has a "LO" alarm limit range from 0.5 to 10.0 by increments of 0.1.

6.18.4 Adjust the "LO" MIN VOL alarm to 2.0 liters.

6.18.5 Touch the volume "ALARMS ON" to enable the volume alarms and start a stopwatch.

6.18.6 What is the time when the "APNEA-VOLUME" is activated under the CAUTION column? ___ sec (13-17)

6.18.7 What is the time when the "APNEA-VOLUME" is activated under the WARNING column? ___ sec (26-34)

6.18.8 Insert a calibrated volumeter in between the Spiromed sensor (or absorber, if the system is equipped with an ultrasonic flow sensor) and the exhalation valve.

6.18.9 Attach a patient circuit to the absorber system.

6.18.10 Turn the ventilator ON.

6.18.11 Adjust the frequency to 6.

6.18.12 Adjust the I:E Ratio to 1:2.

6.18.13 Adjust the flow to the maximum of the LOW zone.

6.18.14 Adjust the oxygen flow to 2 l/min.

6.18.15 Adjust the Tidal Volume to 200 ml.

6.18.16 After the first breath is detected, does the "APNEA-VOL" in the WARNING column and the "MIN VOL LOW" in the CAUTION column deactivate? ___ (Y)

6.18.17 After one (1) minute, does the "MIN VOL LOW" message appear in the CAUTION column? ___ (Y)

6.18.18 Adjust the "LO" alarm limit 0.1 liter below the indicated minute volume.

6.18.19 Does the "MIN VOL LOW" in the CAUTION column deactivate? ___ (Y)

6.18.20 Increase the tidal volume to 1000 ml and the frequency to 10 BPM. Readjust the inspiratory flow as necessary to fully collapse the bellows.

6.18.21 Is the "TID VOL" on the Spiromed (or ultrasonic flow sensor) and the volumeter within 20% of each other? ___ (Y)

6.18.22 Is the "MIN VOL" on the Spiromed (or ultrasonic flow sensor) and the volumeter within 20% of each other? ___ (Y)

6.18.23 Create a reverse flow by loosening the expiratory valve dome. If equipped with an ultrasonic flow sensor, remove the breathing hose from the flow sensor. Connect a test terminal and a Riken aspirator (negative pressure squeeze bulb) to the 22 mm male port of the flow sensor. Disconnect the hose from the expiratory valve. Compress and release the aspirator.

6.18.24 Each time a reverse flow of greater than 20 ml is detected, does the "REVERSE FLOW" message appear in the ADVISORY column? ___ (Y)

6.18.25 Tighten the expiratory valve dome. If equipped with an ultrasonic flow sensor, remove the test terminal and aspirator from the flow sensor and reconnect the patient circuit hose. Reconnect the hose terminal from the flow sensor to the expiratory valve.

6.18.26 Disconnect the volume sensor cord from the "VOLUME SENSOR" interface.

6.18.27 Does the "VOL SEN DISC" and "VOL ALRM OFF" messages appear in the ADVISORY column? ___ (Y)

6.18.28 Reconnect the volume sensor cord to the "VOLUME SENSOR" interface.

6.18.29 Turn OFF the ventilator.

6.18.30 Disable the APNEA-PRESSURE and APNEA-VOLUME alarms.

6.18.31 Remove the test volumeter and set the System Power switch to STANDBY.

## 6.19 Alarm Circuit Delay Test

6.19.1 Create any "Warning Alarm" condition.

6.19.2 Press the alarm circuit delay button located on the remote display.

6.19.3 Verify that the audio portion of the alarm is silenced.

6.19.4 Verify a "60" appears at the bottom located on the remote display.

6.19.5 Press the Alarm Circuit Delay twice.

6.19.6 Verify that a "120" appears at the bottom of the remote display.

## 6.20 Apnea Pressure Test

6.20.1 Disconnect the pressure pilot line from the absorber.

6.20.2 Zero a calibrated pressure meter to ambient air pressure.

6.20.3 Connect the pilot line to the tee adapter of a calibrated pressure meter and syringe.

6.20.4 Adjust the frequency to "00".

6.20.5 Adjust the threshold to 8 cm (using the monitor set-up screen and rotating the dial selector).

6.20.6 Simultaneously, turn the ventilator ON and start the stopwatch.

6.20.7 After 15 +/-3 seconds, an APNEA PRESSURE ALARM will appear in the CAUTION section on the remote display.

6.20.8 After another 15 +/-3 seconds have passed, the APNEA ALARM shall upgrade to a WARNING.

6.20.9 Slowly increase the test pressure. The alarm shall deactivate at 8cm +/-1 cm $H_2O$.

6.20.10 Repeat steps using 12.0 cm $H_2O$.

6.20.11 Repeat steps using 26.0 cm $H_2O$.

6.20.12 Turn the ventilator OFF. Turn all alarms OFF.

### 6.21 High Pressure Alarm Test

6.21.1 Verify that the HIGH alarm is set at 50 cm $H_2O$.

6.21.2 Increase the test pressure to 50 cm $H_2O$. A VENT PRESSURE HIGH alarm shall activate as a warning.

### 6.22 Sub-Atmospheric Pressure Alarm Test

6.22.1 Apply a negative test pressure of -10 cm $H_2O$.

6.22.2 A "SUB-ATMOS" warning alarm shall activate.

### 6.23 Continuing Pressure Alarm Test

6.23.1 Increase the test pressure above the threshold value shown on the display, and begin timing with a stopwatch.

6.23.2 After 15 seconds, a continuous "WARNING" pressure alarm shall activate.

6.23.3 Decrease the pressure to a value below the threshold, and the alarm shall cease.

### 6.24 Oxygen Ratio Monitor Control (ORMC) Test

NOTE: Refer to 6.24A if machine is equipped with an ORC.

6.24.1 Open the oxygen and nitrous oxide cylinder valves.

6.24.2 Depress the "$O_2$ FLUSH" for 15 seconds.

6.24.3 Turn the $N_2O$ flow control valve counter-clockwise to its stop position.

6.24.4 Slowly increase the oxygen flow until nitrous oxide begins to flow.

6.24.5 What is the oxygen flow rate? ___(200-300 ml/min.)

6.24.6 Slowly increase the oxygen flow until the "$O_2/N_2O$ FLOW RATIO" LED on the alarm panel is lighted.

6.24.7 What is the nitrous oxide flow rate? ___(150-300 ml/min.)

6.24.8 Set the oxygen flow to 1000 ml/min.

6.24.9 Adjust the nitrous oxide flow until the ORMc controls the nitrous oxide.

6.24.10 What is the oxygen concentration? ___ % (21-29)

6.24.11 Does the "$O_2/N_2O$ FLOW RATIO" LED turn "ON" on the ALARM PANEL? ___ (Y)

6.24.12 Does the "$O_2/N_2O$ LOW" message appear in the ADVISORY column? ___ (Y)

6.24.13 Open the nitrous oxide flow control valve to the stop position.

6.24.14 Adjust the oxygen flow to 1.5 l/min.

6.24.15 What is the oxygen concentration? ___ % (21-29)

6.24.16 Adjust the oxygen flow to 2 l/min.

6.24.17 What is the oxygen concentration? ___ % (21-29)

6.24.18 Adjust the oxygen flow to 3 l/min.

6.24.19 What is the oxygen concentration? ___ % (21-29)

6.24.20 Set the LOCK OUT device to "ALL GASES".

6.24.21 Is the "$O_2/N_2O$ FLOW RATIO" alarm activated? ___ (N)

6.24.22 Set the LOCK OUT device to "$O_2+N_2O$".

6.24.23 Close the oxygen flow control valve.

6.24.24 What is the flow of nitrous oxide? ___ ml/min. (0)

6.24.25 Is the "$O_2/N_2O$ FLOW RATIO" alarm activated? ___ (N)

6.24.26 Close the nitrous oxide flow control valve.

6.24.27 Turn the System Power switch to STANDBY.

### 6.24A Oxygen Ratio Control (ORC) Test

* 6.24A.1 Set the Gas Selector switch to $O_2$ + $N_2O$.

6.24A.2 Open the oxygen and nitrous oxide cylinder valves.

6.24A.3 Depress the $O_2$FLUSH for 15 seconds.

6.24A.4 Set the oxygen flow to 1000 ml.

6.24A.5 Open the nitrous oxide flow control valve to the stop position.

6.24A.6 What is the oxygen concentration? ___ % (22-28)

6.24A.7 Adjust the oxygen flow to 1.5 l/min.

6.24A.8 What is the oxygen concentration? ___ % (22-28)

6.24A.9 Adjust the oxygen flow to 2 l/min.

6.24A.10 What is the oxygen concentration? ___ % (22-28)

6.24A.11 Adjust the oxygen flow to 3 l/min.

6.24A.12 What is the oxygen concentration? ___ % (22-28)

6.24A.13 Reduce the $O_2$ flow to 500 ml/min. Verify that the $N_2O$ flow is greater than or equal to 600 ml/min.

6.24A.14 Slowly close the oxygen flow control valve.

* 6.24A.15 What is the flow of nitrous oxide? ___ ml/min. (0)

** 6.24A.16 What is the oxygen concentration with the $O_2$ flow control valve closed?___% (22-28)

6.24A.17 Close the nitrous oxide flow control valve.

* These items do not apply to machines with later design (P/N 4113329-001) ORC.
** This item does not apply to machines with early design (P/N 4111800) ORC.

## 6.25 SPO2/Pulse - Nellcor

6.25.1 Plug the $SpO_2$ sensor pre amp cable into the machine interface.

6.25.2 Disconnect the Durasensor from the interface cable and pre-amp and attach a Nellcor® pocket simulator Model 2500.

6.25.3 The monitor should display a value between 80 and 82 for oxygen saturation and a value between 60 and 62 for a pulse rate if the machine is equipped with a Nellcor MP-202 pulse oximeter module. Record the values on the report.

If the machine is equipped with a Nellcor MP-203 pulse oximeter module, the pulse rate displayed should be between 39 and 41.

6.25.4 Disconnect the pocket sensor and re-connect the finger probe.

6.25.5 Attach the sensor to the operator's finger and obtain a pulse and oxygen saturation.

6.25.6 Disconnect the sensor from the finger.

6.25.7 After ten (10) seconds, the Warning message "NO SpO2 PULSE" shall appear on the central alarm display and a continuous audible alarm shall sound.

6.25.8 Re-connect the sensor to the finger.

6.25.9 Note the pulse high and low alarm limit settings. After pulse and oxygen saturation readings stabilize, raise the pulse low alarm limit above the actual pulse rate.

6.25.10 The Warning message "SpO2 PULSE LOW" shall appear on the central alarm display and a continuous audible alarm shall sound.

6.25.11 Return the pulse low alarm limit to its previous setting.

6.25.12 Decrease the pulse high alarm limit below the actual pulse rate.

6.25.13 The Caution message "OXI PULSE HIGH" shall appear on the central alarm display and an intermittent audible alarm shall sound.

6.25.14 Return the pulse high alarm limit to its previous setting.

6.25.15 Note the SpO2 SAT high and low alarm settings. Raise the SAT low alarm limit above the actual SpO2 level.

6.25.16 The Warning message "SpO2 SAT LOW" shall appear on the central alarm display and a continuous audible alarm shall sound.

6.25.17 Return the SAT low alarm to its previous setting.

6.25.18 Decrease the SAT high alarm limit below the actual SpO2 level.

6.25.19 The caution message "SPO2 SAT HIGH" shall appear on the central alarm display and an intermittent audible alarm shall sound.

6.25.20 Return the SAT high alarm to its previous setting.

6.25.21 Remove sensor from finger and set SpO2 monitor to Standby.

## 6.25A SpO2 Monitor Calibration Check - Novametrix

6.25A.1 Plug the SpO2 sensor extension cable into the machine interface.

6.25A.2 Disconnect the finger probe from the extension cable and attach a Novametrix TB500B sensor simulator to the extension cable.

6.25A.3 Turn the System Power switch to ON. press and hold the Selection Dial, and simultaneously press the MONITOR and SYSTEM CONFIG keys to enter the main service screen. Touch the MONITORS key to bring up a second column of touch keys.

6.25A.4 Touch the SpO2 key on the screen.

6.25A.5 Set the simulator's Sensor Type switch to 87XX. Set the output signal to 3 and the saturation to 82%. Turn the simulator ON and verify that the monitor's displayed Pulse reading is 60 ±1 BPM and the SaO2 reading is 82 ±2.

NOTE: Do not rely on the simulator's low battery LED as an indicator of sufficient battery power. Replace the battery with a fresh 9 volt transistor battery if proper measured values are not obtained and the battery measures ≤8.5 VDC.

6.25A.6 Adjust the simulator's saturation setting to 100 and verify that the monitor indicates 99 ±1. Adjust the saturation to 62 and verify that the monitor indicates 62 ±2.

6.25A.7 Depress the Open Test RED key and verify that the PULSE LO LED activates, a continuous audible alarm is heard, and a NO OXI PULSE warning alarm is shown on the central alarm display.

6.25A.8 Depress both Open Test keys together and verify that the monitors SaO2 and OXI ALARMS DISABLE indicators activate, a single audible tone is heard, and OXI SEN DISC advisory alarm is shown on the central alarm display. Release the Open Test keys.

6.25A.9 Disconnect the simulator and re-connect the finger probe. Attach the sensor to the operator's finger and obtain pulse, and oxygen saturation readings. Disconnect the sensor from the finger. Afther ten (10) seconds, the Warning message NO OXI PULSE shall appear on the central alarm display and a continuous audible alarm shall sound.

6.25A.10 Re-connect the sensor to the finger.

6.25A.11 Note the pulse high and low alarm settings. After pulse and oxygen saturation readings stabilize, raise the pulse low alarm limit above the actual pulse rate.

6.25A.12 The Warning message OXI PULSE LOW shall appear on the central alarm display and a continuous audible alarm shall sound.

6.25A.13 Return the pulse low alarm to its previous settings.

6.25A.14 Decrease the pulse high alarm limit below the actual pulse rate.

6.25A.15 The caution message OXI PULSE HIGH shall appear on the central alarm display and an intermittent audible alarm shall sound.

6.25A.16 Return the pulse high alarm limit to its previous setting.

6.25A.17 Note the SpO2 SAT high and low alarm settings. Raise the SAT low alarm limit above the actual SpO2 level.

6.25A.18 The Warning message SpO2 SAT LOW shall appear on the central alarm display and a continuous audible alarm shall sound.

6.25A.19 Return the SAT low alarm to its previous setting.

6.25A.20 Decrease the SAT high alarm limit below the actual SpO2 level.

6.25A.21 The caution message SpO2 SAT HIGH shall appear on the central alarm display and an intermittent audible alarm shall sound.

6.25A.22 Return the SAT high alarm to its previous setting.

6.25A.23 Remove finger from sensor and set the SpO2 monitor to Standby.

## 6.26 NIBP Alarm and Pressure Tests

6.26.1 Install the BP cuff on left arm.

6.26.2 Touch the INTERVAL box. Using the selection dial, decrement to one (1) minute.

6.26.3 Touch START.

6.26.4 When the cuff cycle is complete, touch SYSTOLIC LOW. Adjust to above the actual value. NIBP systolic low appears as a caution. Decrease to below the actual value and the alarm should cease.

6.26.5 Adjust the SYSTOLIC HIGH to below the actual value. NIBP systolic high appears as a caution. Readjust to above the actual value. The alarm should cease.

6.26.6 Touch STAT. The cuff should inflate. The time between deflation and the next inflation should be three (3) seconds.

For the following tests, access the MONITORS and NIBP Service Screen as outlined in Section 2.

### 6.26.7 NIBP Inflation Pressure Test

6.26.7.1 Wrap an adult BP cuff loosely around a cylindrical object. Attach, in series, a tee fitting with a calibrated manometer between the patient cuff and the hose assembly.

6.26.7.2 Bring up the MONITORS service screen and select NIBP.

6.26.7.3 Touch the INFLATE key. The cuff shall inflate to 180 to 190 mm Hg. Touch the STOP key to end the test. Record the value on the report.

### 6.26.8 NIBP Inflation Time Test

6.26.8.1 Touch the INFLATION CHECK key. The MEAN value displayed shall not be greater than 73, indicating the time (in x.x seconds), to reach a pressure of 250 mm Hg.

6.26.8.2 The PULSE value displayed shall not be greater than 73, indicating the time (in x.x seconds), to reach a pressure of 300 mm Hg.

NOTE: Test failure may be due to cuff wrapped too tightly, or cuff may be too small. Use an adult cuff.

### 6.26.9 NIBP Leak Test

6.26.9.1 Touch the LEAKAGE CHECK key. After one minute, the SYSTOLIC value displayed shall be between 280 and 300.

6.26.9.2 After four minutes, the DIASTOLIC value displayed shall not be greater than 8 (indicating the amount of pressure drop at the end of the test period).

### 6.26.10 NIBP Cycle Test

6.26.10.1 Touch the TAKE READING key and begin timing with a stopwatch. The cuff shall inflate, and then deflate within 29 to 31 seconds after the start of inflation.

## 6.27 Agent Analyzer Accuracy Test

NOTE: Before performing the accuracy test, the Multispec must be in the full accuracy mode. The $CO_2$ and Agent warm-up messages shall not appear on the advisory display.

NOTE: Before performing the accuracy test, the oxygen analyzer must display 21% $FIO_2$. The sensor must be exposed to ambient air during the entire Multispec accuracy testing.

### 6.27.1 Sample Flow Test

6.27.1.1 Verify that an oxygen supply is connected to the machine.

6.27.1.2 Examine the sample circuit consisting of the airway adapter/filter, sample line, and auxiliary water trap. Replace any components as needed.

6.27.1.3 Connect a capnomed flowmeter test stand to the patient sample exhaust port.

6.27.1.4 Verify that the sample flow is within 175 to 225 ml/min.

### 6.27.2 Line Block Test

6.27.2.1 Remove the calibration gas cylinder from the multispec calibration adapter.

6.27.2.2 Set both flow control valves on the multispec calibration adapter fully counter-clockwise.

6.27.2.3 Attach the patient sample line to the luer lock fitting on the calibration adapter.

6.27.2.4 Turn the flow control valve clockwise until the capnomed flowmeter indicates 75 ml/min.

6.27.2.5 Verify that a "Line Block" message illuminates on the remote display in approximately 15 seconds.

6.27.2.6 Remove the test equipment.

NOTE: Before performing the accuracy test, the vaporizers must be exposed to a constant temperature (preferably 22° C) for at least one hour.

### 6.27.3 Accuracy Test

6.27.3.1 Press the "MONITOR SETUP" key. Touch the "CO2 CAL" soft key on the left monitor display.

6.27.3.2 Touch the "SELECT" soft key on the right display, and configure the display to indicate "HAL".

6.27.3.3 Press the "DATA" key. Touch the "GAS ANALYSIS" soft key if it is not illuminated.

6.27.3.4 Attach the $CO_2$ calibration adapter assembly (P/N 4110216 A) to the $CO_2$ calibration cylinder (P/N 4107979 P)

6.27.3.5 Turn the flow control valve on the calibration adapter slightly counter-clockwise.

6.27.3.6 After the $CO_2$ waveform peaks on the remote display, turn off the flow and remove the sample line from the calibration adapter.

6.27.3.7 Verify that the "EXP" $CO_2$ display indicates within 36.0 to 40.0 mm Hg.

6.27.3.8 Verify that the "EXP" halothane on the agent display indicates within 0 to 0.4%

6.27.3.9 Verify that the "EXP" $N_2O$ indicates within 32.0 to 38.0%.

6.27.3.10 Press the "MONITOR SETUP" key. Touch the "F GAS" soft key on the agent monitor display.

6.27.3.11 Ensure that all vaporizer handwheels are set to the zero, or OFF position.

6.27.3.12 Fill each vaporizer with the correct anesthetic agent until the liquid level is within the correct range as indicated on the sight glass. DO NOT OVER FILL.

6.27.3.13 Calibrate a Riken gas indicator as per manufacturer's instructions.

6.27.3.14 Insert the patient circuit elbow into the fresh gas outlet.

6.27.3.15 Connect a sampling "T" between the elbow and the fresh gas hose.

6.27.3.16 Turn the APL valve knob fully counter-clockwise to its open position.

6.27.3.17 Attach a short 22 mm hose between the inspiratory and expiratory valves.

6.27.3.18 Attach a breathing bag to swivel bag mount connector.

6.27.3.19 Set the oxygen flow to 10 l/min. to flush the system of residual gases.

6.27.3.20 Reduce the oxygen flow to 4.0 l/min.

6.27.3.21 Slowly adjust the Halothane vaporizer to 1.0% volume concentration, and wait five minutes for the vaporizer to stabilize.

6.27.3.22 Record the current value shown on the Riken gas analyzer.

6.27.3.23 Verify that the displayed "EXP HAL" value is within the sum of the tolerances of the vaporizer and the Riken gas indicator.

6.27.3.24 Slowly adjust the vaporizer to 2.5% volume concentration, and wait five minutes for the vaporizer to stabilize.

6.27.3.25 Repeat Steps 6.27.3.22 and 6.27.3.23.

6.27.3.26 Slowly adjust the vaporizer to 4.0% volume concentration, and wait five minutes for the vaporizer to stabilize.

6.27.3.27 Repeat Steps 6.27.3.22 and 6.27.3.23.

6.27.3.28 Turn the vaporizer OFF.

6.27.3.29 Repeat Steps 6.27.3.19 thru 6.27.3.28 for the other two vaporizers. When comparing displayed values with the Riken gas analyzer readings, apply the following conversion factors to the readings obtained with the Riken Model 18H gas analyzer:

Enflurane x 1.08
Isoflurane x 1.05
Sevoflurane x 1.09

NOTE: If any reading is outside of the Multispec tolerance limits, the Multispec analyzer must be recalibrated in accordance with the procedure given in Section 5, and then Procedure 6.27 must be repeated.

## 6.28 Open Reservoir Scavenger

6.28.1 Remove all scavenger hoses one at a time and drain all accumulated moisture. Inspect all scavenger hoses for deterioration and replace any worn hoses.

6.28.2 Disconnect the hospital vacuum source from the scavenger.

6.28.3 Remove the scavenger flow control needle valve assembly. Inspect the needle valve and seat for lint or dust acumulation. Clean with compressed air if necessary, and reinstall the needle valve assembly.

6.28.4 Remove the scavenger mounting screws.

6.28.5 Remove the two screws securing the access panel at the bottom of the scavenger canister.

6.28.6 Remove and inspect the silencer; replace if needed.

6.28.7 Remove the reservoir canister from the scavenger body by unscrewing the four socket head cap screws located at the top of the canister.

6.28.8 Remove the flowmeter from its housing by turning it counter-clockwise. Inspect the tube and clean with compressed air if needed.

6.28.9 Reassemble the scavenger assembly, and reactivate the vacuum source.

6.28.10 Perform the following negative pressure relief test:

6.28.10.1 Connect a 19 mm scavenger hose between the bottom of the absorber pole and the right-hand port on the scavenger. Connect a 19 mm scavenger hose between the APL valve and the rear port on the absorber pole. The left-hand scavenger port may be capped for this test, or may be connected to the ventilator relief valve. Connect a DISS vacuum hose to the threaded terminal on the left side of the scavenger. Alternatively, an adapter can be used to attach a wall suction hose to the hose barb fitting on the adapter.

6.28.10.2 Connect a short 22 mm breathing hose from the inspiratory valve to the expiratory valve on the absorber, or the expiratory hose terminal on the ultrasonic flow sensor, if applicable. Set the Man/Auto selector valve to the BAG position. Turn the APL valve control knob fully counter-clockwise.

6.28.10.3 Verify that the suction waste gas disposal system is active.

6.28.10.4 Adjust the scavenger needle valve until the flowmeter indicates between the white lines. Close all flow control valves on the anesthesia machine. Occlude the absorber breathing bag terminal.

6.28.10.5 Install a scavenger adapter (P/N 4108114) with a hose barb between the 19 mm hose terminal of the scavenger, and the scavenger hose. Connect a test pressure monitor to the hose barb on the adapter and observe the pressure reading on the test gauge. The gauge shall indicate a pressure of 0 to -0.5 cm $H_2O$.

6.28.11 Perform the following positive pressure relief test:

6.28.11.1 Perform Steps 6.28.10.1 thru 6.28.10.3.

6.28.11.2 If the absorber system or ventilator bellows are equipped with a PEEP valve, turn the PEEP valve control knob fully counter-clockwise.

6.28.11.3 Turn the scavenger needle valve fully clockwise (closed).

6.28.11.4 Open the oxygen flow control valve on the anesthesia machine to a flow of 10 l/min. and occlude the absorber breathing bag terminal.

6.28.11.5 The flow of oxygen shall now exit the system through the relief ports around the top of the canister. The test pressure gauge shall indicate a pressure less than 1.0 cm $H_2O$.

6.28.11.6 After the test, adjust the scavenger needle valve for a flowmeter indication halfway between the two white lines.

## 6.28A Scavenger Interface, A/C

6.28A.1 Remove all scavenger hoses one at a time, and drain all accumulated moisture. Inspect all scavenger hoses for deterioration and replace any worn hoses.

6.28A.2 Remove the safety relief valve housing by unscrewing it in a counter-clockwise direction.

6.28A.3 Inspect the rubber O-ring and replace if worn.

6.28A.4 Remove the safety relief valve from its housing by twisting it out in a counter-clockwise direction. The tips of needle-nose pliers can be used to turn the valve. Be careful not to damage the valve disk.

6.28A.5 Remove any accumulated lint or dust from the valve with a soft brush. The valve may be further cleaned with a low flow of clean air or oxygen. The scavenger body can be cleaned with a moist cloth.

6.28A.6 Reinstall the valve into the housing, making sure that it is threaded all the way into the housing and that the plastic washer is properly seated on its upper surface.

6.28A.7 Make sure that the interior of the valve body is completely dry. Reinstall the valve housing onto the scavenger body, making sure that the O-ring is properly seated.

6.28A.8 Perform the following Pre-Use Checkout procedure:

6.28A.8.1 Connect a 19 mm scavenger hose between the bottom of the absorber pole and the right-hand port on the scavenger. Connect a short 19 mm scavenger hose between the APL valve and the port on the rear of the absorber pole. Connect a 19 mm scavenger hose between the ventilator relief valve and the left-hand port on the scavenger.

6.28A.8.2 Connect a short 22 mm breathing hose from the inspiratory valve to the expiratory valve on the absorber, or the expiratory hose terminal on the ultrasonic flow sensor, if applicable.

6.28A.8.3 Set the Man/Auto valve to the AUTO position.

6.28A.8.4 If the absorber system or ventilator bellows are equipped with a PEEP valve, turn the PEEP valve control knob fully counter-clockwise.

6.28A.8.5 Set the oxygen flow to 10 l/min. and occlude the 19 mm scavenger terminal labeled EXHAUST.

6.28A.8.6 After the ventilator bellows inflates, the flow of oxygen will exit the system through the positive pressure safety relief valve. At this point, the absorber system breathing pressure gauge shall indicate a pressure of 10.0 cm $H_2O$ or less.

## 6.28B Scavenger Interface

6.28B.1 Check all scavenger hoses and reservoir bag for deterioration. Replace all worn components.

6.28B.2 Negative Relief Valve Cleaning:

6.28B.2.1 Remove the plastic valve cover on the front surface of the scavenger body by turning it in a counter-clockwise direction.

6.28B.2.2 Remove the valve and washer from the scavenger body by turning it counter-clockwise. A needle-nose pliers may be used to turn the valve, but use care not to damage the valve's fragile disk.

6.28B.2.3 Brush any accumulated lint or dust off the valve with a soft brush. The valve may be further cleaned with a low flow of clean air or oxygen.

6.28B.2.4 Reinstall the plastic washer and valve into the scavenger body. Replace the valve cover.

6.28B.3 Negative Relief Safety Valve Cleaning:

6.28B.3.1 Unscrew the chrome plated valve housing on the left side of the scavenger body by turning its fitting counter-clockwise with a wrench.

6.28B.3.2 Unscrew the valve from the housing by turning it in a counter-clockwise direction.

6.28B.3.3 Brush any accumulated lint or dust off the valve with a soft brush. The valve may be further cleaned with a low flow of clean air or oxygen.

6.28B.3.4 Reinstall the valve in the housing, and then reinstall the housing into the scavenger body. Note: This valve does not require washers or O-rings.

6.28B.4 Positive Relief Valve Cleaning:

6.28B.4.1 Remove the valve housing on the right side of the scavenger body by turning it counter-clockwise.

6.28B.4.2 Inspect the rubber O-ring and replace if worn.

6.28B.4.3 Remove the valve from the housing by turning it counter-clockwise. A needle-nose pliers may be used to turn the valve, but use care not to damage the valve's fragile disk.

6.28B.4.4 Brush any accumulated lint or dust off the valve with a soft brush. The valve may be further cleaned with a low flow of clean air or oxygen.

6.28B.4.5 Reinstall the valve and plastic washer into the housing.

6.28B.4.6 Reinstall the valve housing onto the scavenger body, making sure that the O-ring is properly seated.

6.28B.5 Negative Pressure Test:

6.28B.5.1 Connect a 22mm breathing hose from the inspiratory valve to the expiratory valve on the absorber, or the expiratory hose terminal on the ultrasonic flow sensor, if applicable. Set the Man/Auto valve to the BAG position. Turn the APL valve fully counter-clockwise. Occlude the bag mount connector.

6.28B.5.2 Verify that the suction waste gas disposal system is active.

6.28B.5.3 Close all flow control valves on the machine. Adjust the scavenger needle valve to allow typical suction through the scavenger.

6.28B.5.4 Install a scavenger adapter (P/N 4108114) with a hose barb between the 19mm hose terminal of the scavenger and the scavenger hose. Connect a test monitor to the hose barb adapter and observe the pressure reading on the test gauge. The gauge shall indicate a pressure of <-1.0 $cmH_2O$.

6.28B.6 Positive Pressure Test:

6.28B.6.1 Close the scavenger needle valve by turning it fully clockwise.

6.28B.6.2 Push the $O_2$ Flush button to inflate the scavenger reservoir bag. Open the oxygen flow control valve to 10 l/min.

6.28B.6.3 Observe the pressure reading on the test gauge. The gauge shall indicate a pressure of <10.0 $cmH_2O$.

6.28B.6.4 Remove the test equipment. Readjust the scavenger needle valve to allow typical suction through the scavenger.

## 6.29 Service Screens

### 6.29.1 Main Service Screen

6.29.1.1 Power the machine up.

6.29.1.2 To access the main service screen, press the MONITOR key, SYSTEM CONFIG key and SELECTION dial simultaneously.

6.29.1.3 Record the information given in the appropriate box.

6.29.1.4 Enter the I.D. number and a service code on the main screen.

6.29.1.5 Touch the first window of the Technical Service Rep. I.D. area on the screen, scroll to the correct number with the selection dial, press DIAL to enter the first digit of the I.D. number. Enter each digit in the same manner, and record at the bottom of the test report.

6.29.1.6 Touch the SERVICE CODE area on the screen, scroll through the list of codes with the selection dial, press DIAL to enter the appropriate code.

6.29.1.7 Touching the RESET area on the screen resets the last service date to the current date and resets the hours running since last service to zero (0).

### 6.29.2 Set P.M.S. criteria.

6.29.2.1 Touch the PMS CRITERIA key.

6.29.2.2 Touch the Month key to advance the display to the next service due date. The internal clock of the machine limits the amount of date advance to a maximum of six (6) months from the current service date.

## 6.30 Oxygen Flush and 100% O2 Final Test

6.30.1 Close the nitrous oxide pipeline shut off valve and cylinder valve.

6.30.2 Set the oxygen flow rate to 5 l/min.

6.30.3 Open the nitrous oxide flow control valve to its counter-clockwise stop.

6.30.4 After the nitrous oxide flow stops, close the nitrous oxide flow control valve.

6.30.5 Close the oxygen flow control valve.

* 6.30.6 Set the LOCK-OUT device to "ALL GASES".

6.30.7 Close the additional gas cylinder and pipeline valves.

6.30.8 Bleed the gas from the additional gas circuits.

* 6.30.9 Set the LOCK-OUT device to "$O_2$ + $N_2O$".

6.30.10 Turn the System Power switch to STANDBY.

6.30.11 Press and release the $O_2$ FLUSH button.

6.30.12 Does the flow of oxygen stop immediately? __ (Y)

6.30.13 Connect a test minute volumeter to the common gas outlet.

6.30.14 Press the $O_2$ FLUSH button for 15 seconds; multiply the value by 4.

6.30.15 What is the oxygen flush flow rate? ___ l/min. (45-65)

6.30.16 Remove the test minute volumeter.

6.30.17 Turn the System Power switch to ON.

6.30.18 Insert the sensor from a calibrated $O_2$ Med into the inspiratory valve dome.

6.30.19 Press the $O_2$ FLUSH button.

6.30.20 What is the $O_2$ concentration? ___ % $O_2$ (97-100)

* These items do not apply to machines with later design (P/N 4113229) ORC.

6.30.21 Remove the $O_2$ Med sensor from the valve dome.

6.30.22 Close the oxygen cylinder valve.

6.30.23 Bleed the oxygen circuit by pressing the $O_2$ FLUSH button.

## 6.31 Final Check

6.31.1 Reinstall the monitor box cover and restore all connections to the patient interface panel.

6.31.2 Verify that the pipeline hoses are connected to the hospital pipeline outlets.

6.31.3 Verify that the APL valve knob is turned completely counter clockwise, fully open.

6.31.4 Verify that the $O_2$ Med sensor is removed from the valve dome adapter.

6.31.5 Verify that the valve dome is plugged.

6.31.6 Verify that the machine is plugged into a live outlet.

6.31.7 Verify the correct date and time on the service log screen.

6.31.8 Return all machine controls and settings to their original state.

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# 7.0 SOFTWARE UPDATE PROCEDURE

This section outlines several software installation methods, and also describes the operation of the Service Software Toolkit (SST).

The Service Software Toolkit (SST) allows all service constants, configurations, logs and templates to be saved to a disk for later viewing or adding to a service report. These same constants can be reloaded after a processor has been replaced. The SST can also be used to install Narkomed 4 software. Actual servicing of the machine is performed manually without the use of SST.

Software updates to the Narkomed 4 anesthesia system, including communication protocols for external monitors are done through a serial port connection to an external PC or through the O.R. Data Manager (ORDM). The software can be downloaded to the PC via modem, or furnished on a floppy disk.

Following is a summary of the software installation methods described in this section:

-- From an external PC using the batch file LOADNM4.BAT. Initial installation will install the SpaceLabs Datalogger, Marquette Tram Net, Datex AS3, and Criticare POET IQ protocols.

-- From the ORDM. Initial installation will install the SpaceLabs Datalogger, Marquette Tram Net, Datex AS3, and Criticare POET IQ protocols.

-- From an external PC using the SST. Any desired protocols may be selected.

-- From the ORDM using the SST. Any desired protocols may be selected.

## 7.1 SOFTWARE TRANSFER TO PC VIA MODEM

Equipment required:

--Interface Cable, NAD Part No. 4109882 P (9-pin to 25-pin)
or 4110328 A (9-pin to 9-pin)
--IBM® PC or IBM PC Compatible configured with:

- PC-DOS or MS-DOS V3.3 or higher
- RS-232C Serial Port connected to COM 1
- Hard Drive or Floppy Drive
- Modem (or external modem)

7.1.1 Call the NAD Technical Service Department and obtain the following information for downloading NARKOMED 4 software:

- System configuration
- Communications protocol

7.1.2 Download the software to the hard disk or to Drive A on the PC.

## 7.2 INSTALLING NM4 SOFTWARE FROM A PC

7.2.1 Set the System Power switch on the NARKOMED 4 to STANDBY, and the power switch on the PC to OFF.

7.2.2 Connect the appropriate interface cable (9-pin or 25-pin) to COM 1 on the PC, and connect the other end of the cable to the NM4 serial interface Port A or Port C as shown in Figure 7-1.

7.2.3 Press and hold the MONITOR SETUP and TREND keys, and turn the System Power switch to ON. Release the MONITOR SETUP and TREND keys when the load mode screen shown in Figure 7-2 appears.

7.2.4 Power up the PC and wait for the DOS prompt to appear on the screen.

7.2.5 Set the PC to read the drive holding the software. For example: if the software was downloaded to drive A, type A: and press ENTER.

7.2.6 Type LOAD_NM4 and press ENTER. Note that the character between LOAD and NM4 is an underline.

Software installation is complete when the machine resets.

7.2.7 Set the System Power switch on the NM4 to STANDBY, and the power switch on the PC to OFF. Disconnect the interface cable.

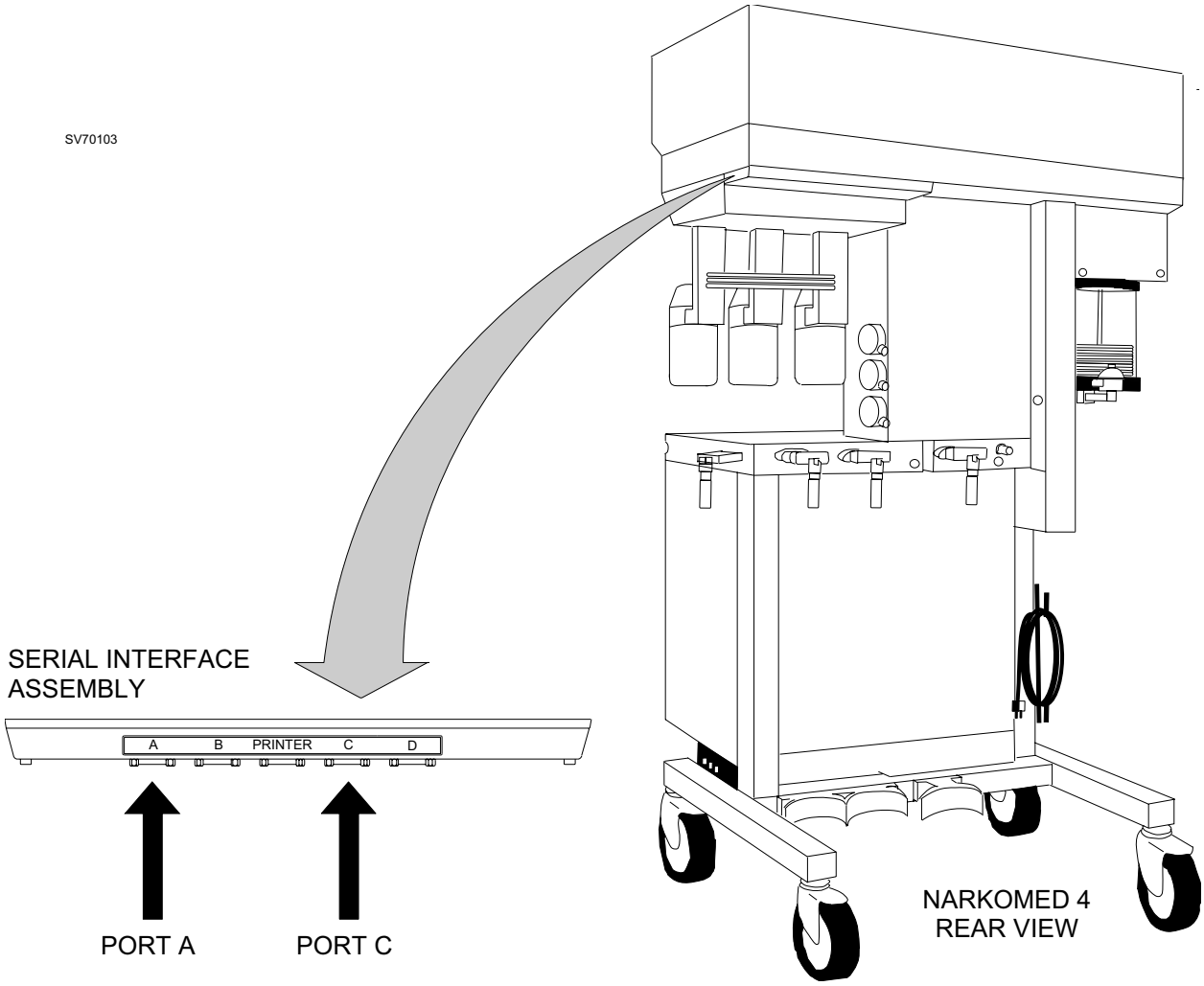



**Figure 7-1: NARKOMED 4 EXTERNAL SOFTWARE LOAD INTERFACE CONNECTION**

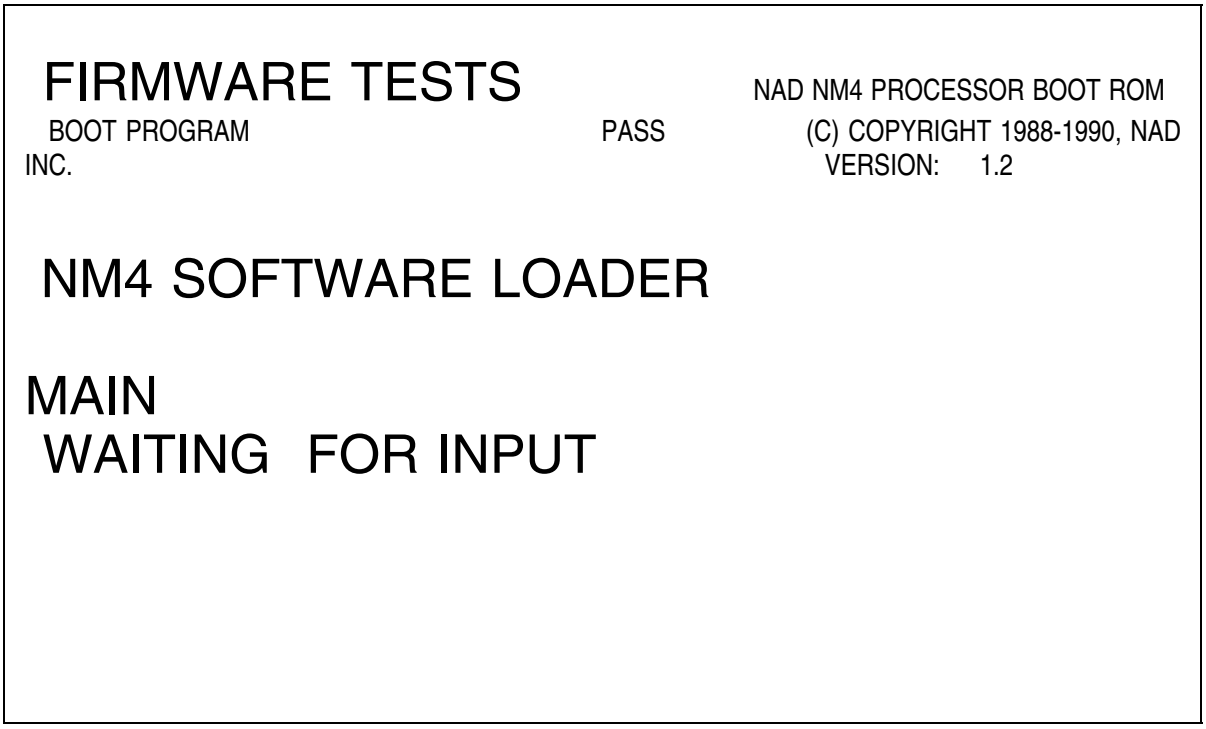



**FIGURE 7-2: NARKOMED 4 LOAD MODE SCREEN**

### 7.3 INSTALLING NM4 SOFTWARE FROM THE ORDM

To install NM4 software from an ORDM, a 3½ in. floppy disk with the Narkomed 4 software is needed.

7.3.1 Insert the floppy disk into the ORDM.

7.3.2 Set the System Power switch on the Narkomed 4 to STANDBY.

7.3.3 Press and hold the MONITOR SETUP and TREND keys, and turn the System Power switch to ON. Release the MONITOR SETUP and TREND keys when the load mode screen shown in Figure 7-2 appears.

Software installation is complete when the machine resets.

## 7.4 INSTALLING NM4 SOFTWARE FROM A PC USING THE SST

Running the SST from an external computer requires an IBM® PC or IBM PC compatible configured with:

PC-DOS or MS-DOS V3.3 or higher
RS-232C Serial Port connected to COM 1
Hard Drive or 3½ in. Floppy Drive

The COM 1 port on the PC must be configured as follows:

| | | | |
|---|---|---|---|
| Baud Rate: | 9600 | Stop Bits: | 1 |
| Parity: | None | Data Bits: | 8 |

The download port (A or C) on the NM4 must be set to Vitalink and be configured as follows:

| | | | |
|---|---|---|---|
| Baud Rate: | 9600 | Stop Bits: | 1 |
| Parity: | None | Data Bits: | 8 |

7.4.1 Verify that the System Power switch on the machine is set to STANDBY, and that the power switch on the PC is OFF.

7.4.2 Connect a 30 in. long Vitalink cable (P/N 4110328) to COM 1 on the PC, and connect the other end of the cable to Port A or Port C on the Narkomed 4 serial port interface (ref. Figure 7-1).

7.4.3 At the DOS prompt, type SST; the SST Main Menu appears (Figure 7-3).

7.4.4 Select ENTER PRIMARY SERVICE from the SST main menu.

7.4.5 Select Load System Software from the Primary Service menu (Figure 7-8); The software load screen shown in Figure 7-9 appears.

7.4.6 Select the desired protocols, and press ESC or F10; follow the on-screen instructions to download the software.

Software installation is complete when the machine resets.

7.4.7 Set the System Power switch on the NM4 to STANDBY, and the power switch on the PC to OFF. Disconnect the interface cable.

## 7.5 INSTALLING NM4 SOFTWARE FROM THE ORDM USING THE SST

In order to run the SST from an ORDM, a 3½ in. floppy disk with Narkomed 4 SST software is needed.

7.5.1 For NM4 software version 1.30:

-- Turn the System Power switch to ON.

-- Press the CONFIG key on the ORDM keyboard, then select Service Functions.

-- Enter the password, and go to DOS by selecting YES from the DOS selection menu. The c:\> prompt will then appear on the remote display.

-- Insert the NM4 SST disk into the ORDM floppy disk drive. On the ORDM:
- on a 286 ORDM, type c:
- on a 386 ORDM, type a:

-- At the ORDM keyboard, type SST and press ENTER; the SST Main Menu appears (Figure 7-3).

7.5.1A For NM4 software version 1.40:

-- Insert the NM4 SST disk into the ORDM floppy disk drive.

-- Turn the System Power switch to STANDBY, then return the switch to ON.

-- Wait for several minutes until the remote display screen displays the SST Main menu (Figure 7-3).

7.5.2 Select ENTER PRIMARY SERVICE from the SST main menu.

7.5.3 Select Load System Software from the Primary Service menu (Figure 7-8); The software load screen shown in Figure 7-9 appears.

7.5.4 Select the desired protocols, and press ESC on the ORDM keyboard; follow the on-screen instructions to download the software.

Software installation is complete when the machine resets.

## 7.6 SST Operation

The SST Main Menu shown in Figure 7-3 appears on the remote display (or external PC).

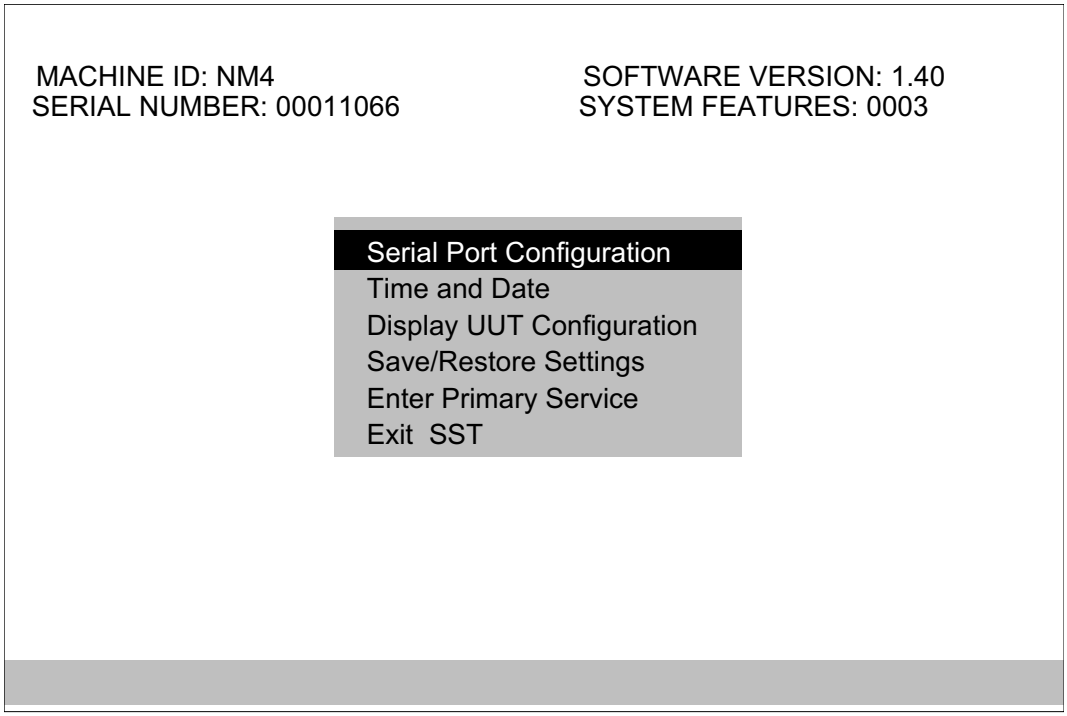



**Figure 7-3: SST MAIN MENU**

In the upper left corner of the screen, MACHINE ID indicates the Narkomed 4 is under test (NM4), and the SERIAL NUMBER of the machine is displayed. The system software version number, and a system features ID number are displayed in the upper right corner of the screen.

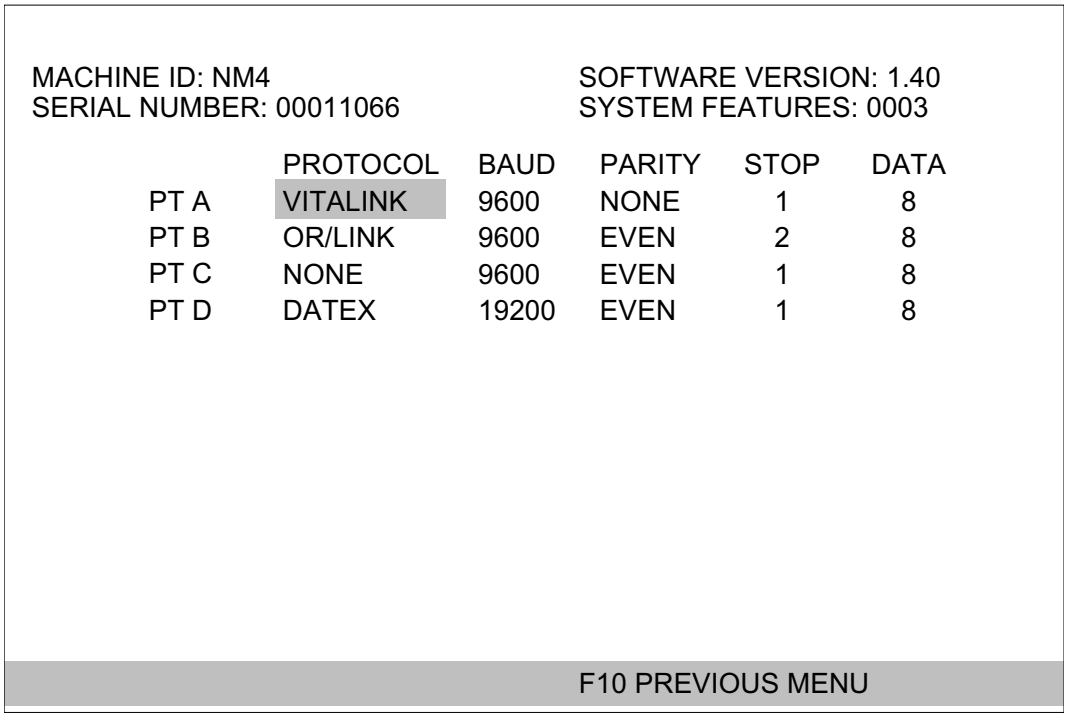
The service functions that are available through the SST main menu are described on the following pages.

To terminate the SST program, use the down arrow key to move the cursor to EXIT SST, and press ENTER.

### 7.6.1 Serial Port Configuration

The screen shown in Figure 7-4 indicates the current configuration parameters for each of the Narkomed 4 serial ports, and also allows changing of these settings.

-- At the SST Main Menu, move the cursor to SERIAL PORT CONFIGURATION and press ENTER to display the Serial Port Configuration screen.


MACHINE ID: NM4
SERIAL NUMBER: 00011066
SOFTWARE VERSION: 1.40
SYSTEM FEATURES: 0003
PROTOCOL BAUD PARITY STOP DATA
PT A VITALINK 9600 NONE 1 8
PT B OR/LINK 9600 EVEN 2 8
PT C NONE 9600 EVEN 1 8
PT D DATEX 19200 EVEN 1 8
F10 PREVIOUS MENU

SV40102

**Figure 7-4: SERIAL PORT CONFIGURATION SCREEN**

-- Move the flashing cursor in the PROTOCOL column to the line corresponding to the port for which you want to change the settings. Only the installed protocols can be selected.

Press ENTER, then use the up or down arrow key to make the selection, and press ENTER again. The cursor will start flashing.

-- Move the flashing cursor to the BAUD column and press ENTER. Use the up or down arrow key to select the desired baud rate, and press ENTER again. The cursor will start flashing.

-- Move the flashing cursor to the PARITY column and press ENTER. Use the up or down arrow key to select the desired parity, and press ENTER again. The cursor will start flashing.

-- Move the flashing cursor to the STOP column and press ENTER. Use the up or down arrow key to select the desired stop bit, and press ENTER again. The cursor will start flashing.

-- Move the flashing cursor to the DATA column and press ENTER. Use the up or down arrow key to select the desired data bits, and press ENTER again. The cursor will start flashing.

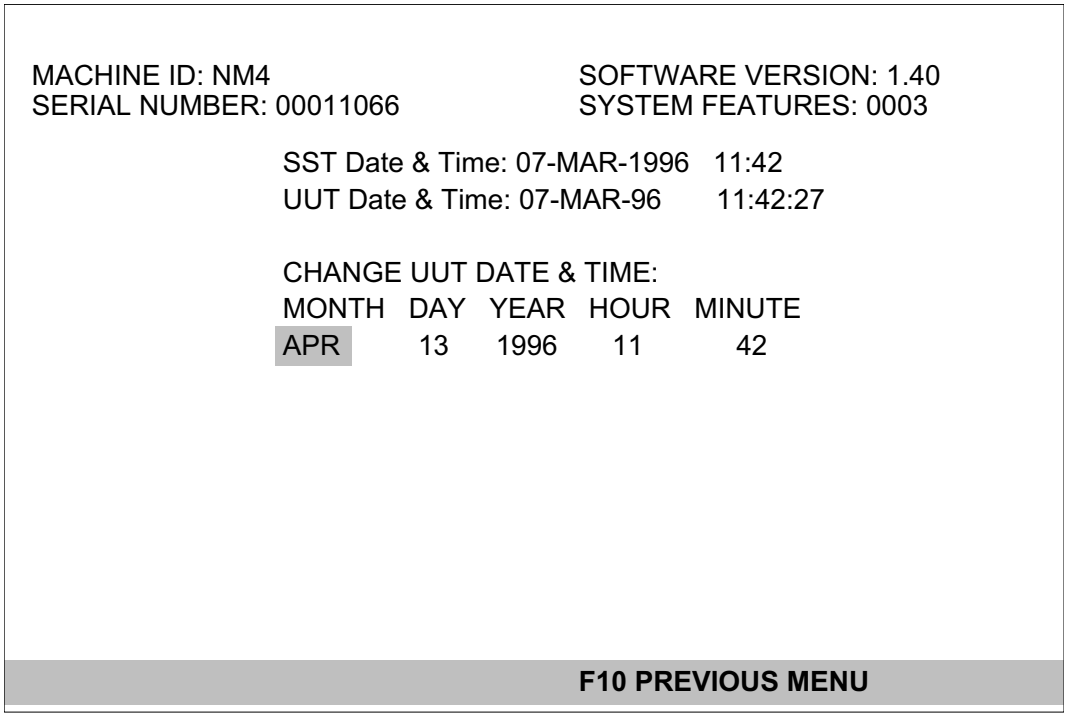
-- On the ORDM keyboard, press ESC to return to the SST Main Menu. (Use F10 on the external PC.)

### 7.6.2 Set Time and Date

The Set Time and Date screen shown in Figure 7-5 allows verification and setting of the machine's clock.

-- At the SST Main Menu, move the cursor to SET TIME AND DATE and press ENTER.

-- Follow the on-screen instructions for setting the month, day, year, hour and minute.


MACHINE ID: NM4
SOFTWARE VERSION: 1.40
SERIAL NUMBER: 00011066
SYSTEM FEATURES: 0003
SST Date & Time: 07-MAR-1996 11:42
UUT Date & Time: 07-MAR-96 11:42:27
CHANGE UUT DATE & TIME:
MONTH DAY YEAR HOUR MINUTE
APR 13 1996 11 42
F10 PREVIOUS MENU

SV40103

**Figure 7-5: SET TIME AND DATE SCREEN**

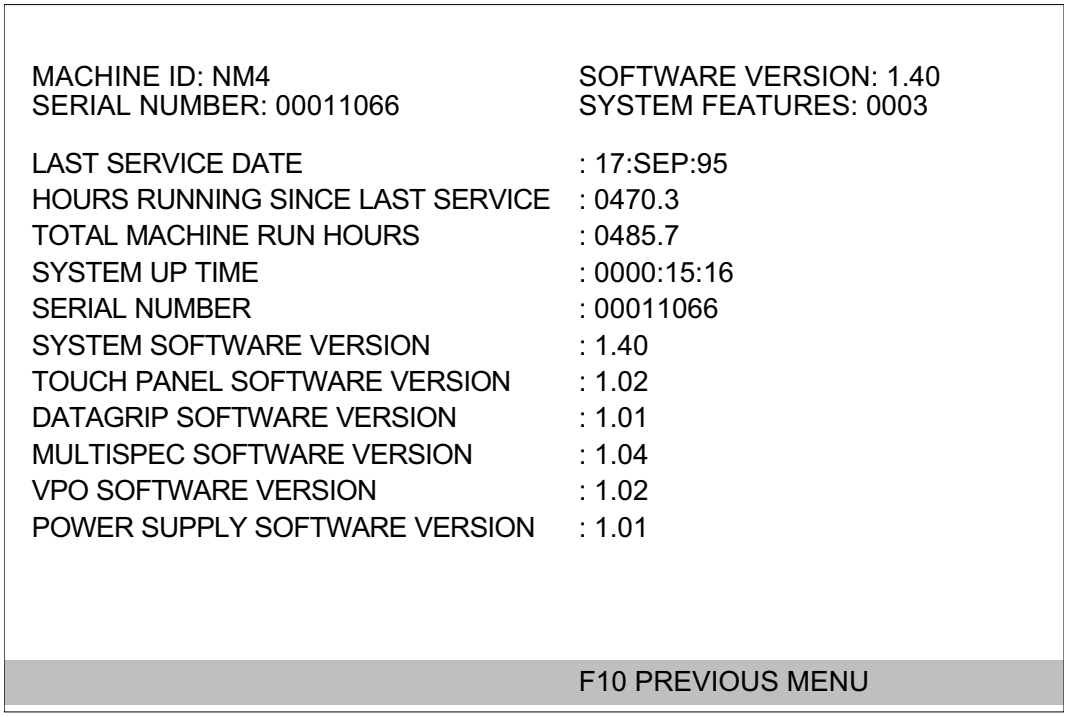
-- On the ORDM, press ESC to return to the SST Main Menu. (Use F10 on the external PC.)

### 7.6.3 Display UUT Configuration

-- The Display Unit Under Test (UUT) Configuration screen (Figure 7-6) shows the last service date, hours running since last service,total machine run hours, system up time, serial number, and the software version number for each of the machine items listed.

-- At the SST Main Menu, move the cursor to DISPLAY UUT CONFIGURATION and press ENTER.

-- On the ORDM, press ESC to return to the SST Main Menu. (Use F10 on the external PC.)


MACHINE ID: NM4
SOFTWARE VERSION: 1.40
SERIAL NUMBER: 00011066
SYSTEM FEATURES: 0003
LAST SERVICE DATE : 17:SEP:95
HOURS RUNNING SINCE LAST SERVICE : 0470.3
TOTAL MACHINE RUN HOURS : 0485.7
SYSTEM UP TIME : 0000:15:16
SERIAL NUMBER : 00011066
SYSTEM SOFTWARE VERSION : 1.40
TOUCH PANEL SOFTWARE VERSION : 1.02
DATAGRIP SOFTWARE VERSION : 1.01
MULTISPEC SOFTWARE VERSION : 1.04
VPO SOFTWARE VERSION : 1.02
POWER SUPPLY SOFTWARE VERSION : 1.01
F10 PREVIOUS MENU

SV40104

**Figure 7-6: DISPLAY UUT CONFIGURATION SCREEN**

### 7.6.4 Save/Restore Settings

This screen allows serial port configuration and templates to be copied to the ORDM disk drive, or to the external PC disk drive. These settings can then be restored from the disk to the machine following any hardware replacement.

-- At the Primary Service Menu (described earlier) set the cursor to SAVE/RESTORE SETTINGS and press ENTER.

-- Move the cursor with the up or down keys to the desired function and press ENTER.

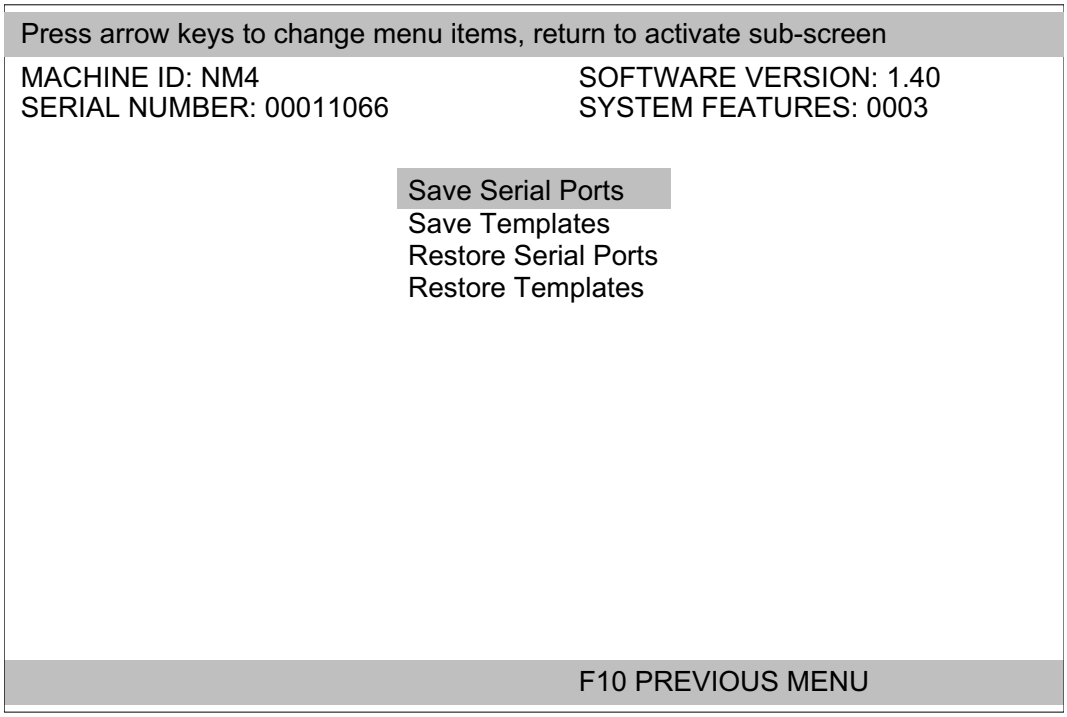



**Figure 7-7: SAVE/RESTORE SETTINGS SCREEN**

-- Press ESC on the ORDM (F10 on the external PC) to return to the Primary Service Menu. If desired, press ESC (or F10) again to return to the SST Main Menu.

### 7.6.5 Primary Service Menu

At the SST Main Menu, move the cursor to ENTER PRIMARY SERVICE and press ENTER. Software installation and other service functions are entered through this screen, shown in Figure 7-8.

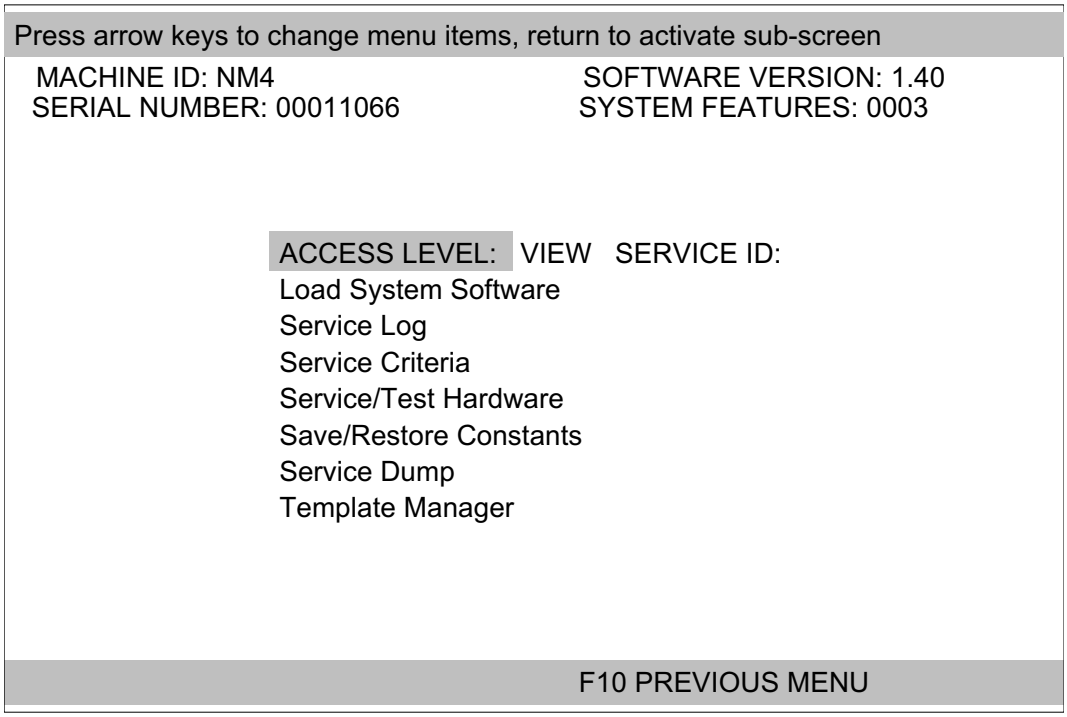



**Figure 7-8: PRIMARY SERVICE MENU**

-- With the flashing cursor at ACCESS LEVEL, press ENTER.

-- Use the up or down arrow key to select the desired mode and press ENTER. The following service modes are available:

VIEW: For verifying machine configuration and status
SERV: For unscheduled service
PMS: For scheduled Periodic Manufacturer's Service
INST: For initial installation

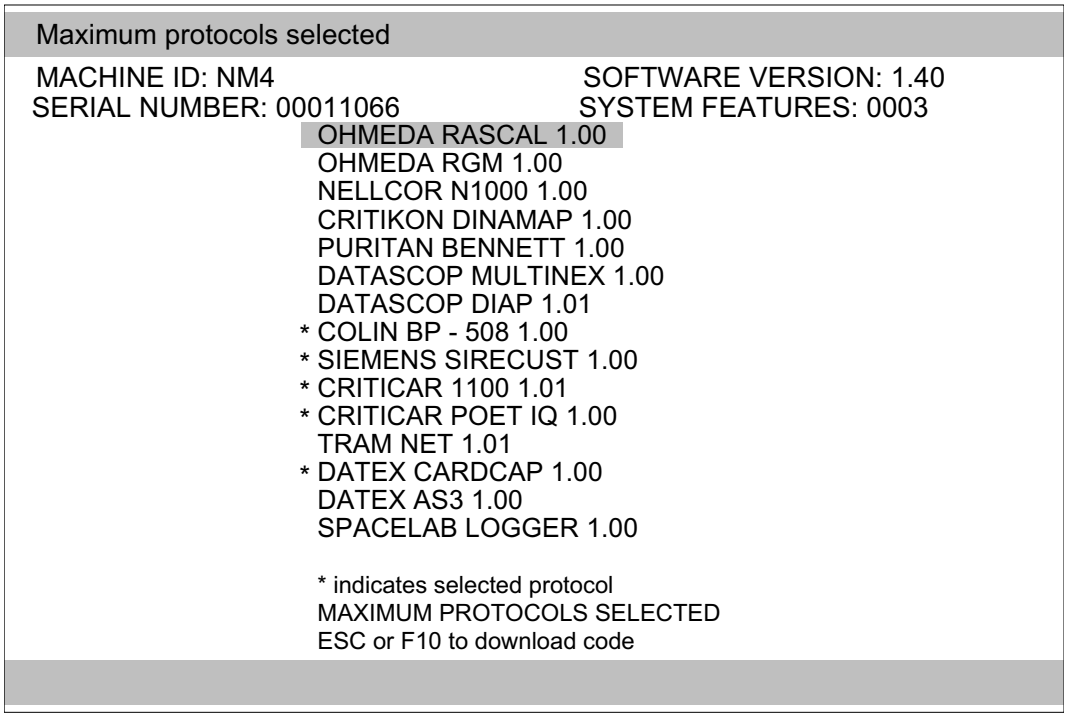
-- Type in your ID on the ORDM or (external PC) keyboard and press ENTER again.

-- Move the cursor with the up or down keys to select the desired functions. These are described in the following paragraphs.

### 7.6.6 Load System Software

This screen displays the list of protocols available for communication with external monitors.

-- At the Primary Service Menu (described earlier) set the cursor at Load System Software and press ENTER.




SV40125

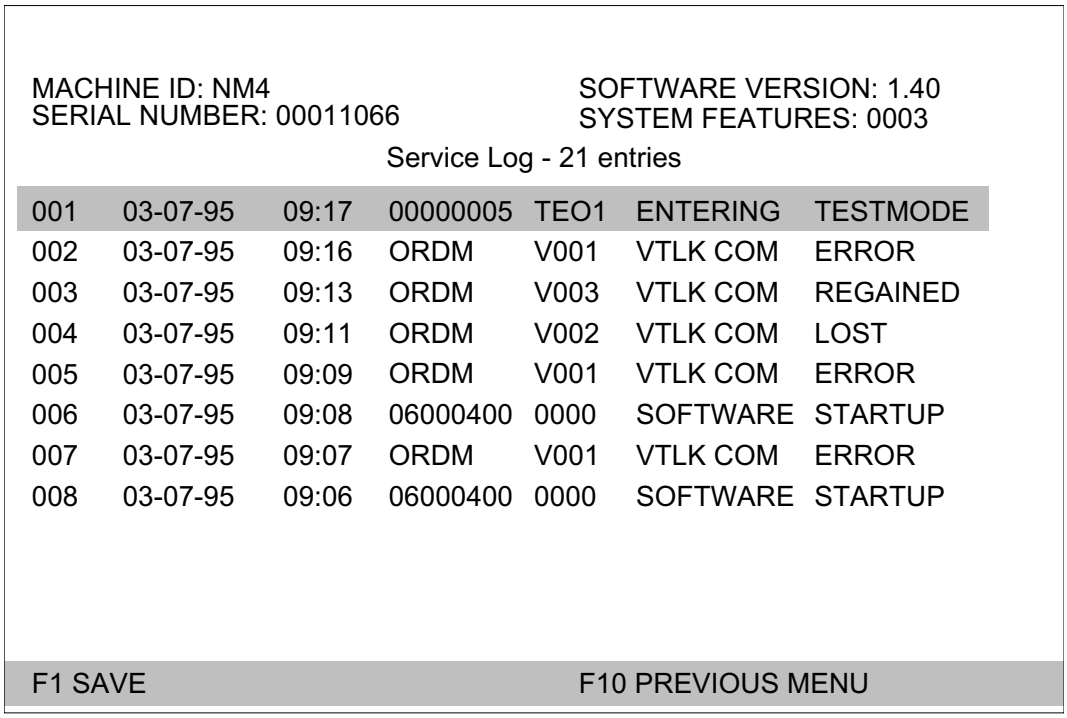
**Figure 7-9: SOFTWARE LOAD SCREEN**

-- Use the up and down arrow keys to scroll through the list; press ENTER to select the desired protocol(s), and press ESC to initiate the downloading process. (Ref. Paragraphs **7.4** and **7.5**)

### 7.6.7 Service Log

This screen displays the service log of the machine showing a list of normal and failed events, error events, service and calibration events. See Figure 7-10.

-- At the Primary Service Menu (described earlier) set the cursor at SERVICE LOG and press ENTER.


MACHINE ID: NM4
SERIAL NUMBER: 00011066
SOFTWARE VERSION: 1.40
SYSTEM FEATURES: 0003
Service Log - 21 entries
001 03-07-95 09:17 00000005 TEO1 ENTERING TESTMODE
002 03-07-95 09:16 ORDM V001 VTLK COM ERROR
003 03-07-95 09:13 ORDM V003 VTLK COM REGAINED
004 03-07-95 09:11 ORDM V002 VTLK COM LOST
005 03-07-95 09:09 ORDM V001 VTLK COM ERROR
006 03-07-95 09:08 06000400 0000 SOFTWARE STARTUP
007 03-07-95 09:07 ORDM V001 VTLK COM ERROR
008 03-07-95 09:06 06000400 0000 SOFTWARE STARTUP
F1 SAVE
F10 PREVIOUS MENU

SV40106

**Figure 7-10: SERVICE LOG SCREEN**

-- Use the up and down arrow keys to scroll through the log; PGUP and PGDN keys to move from page to page in the log.

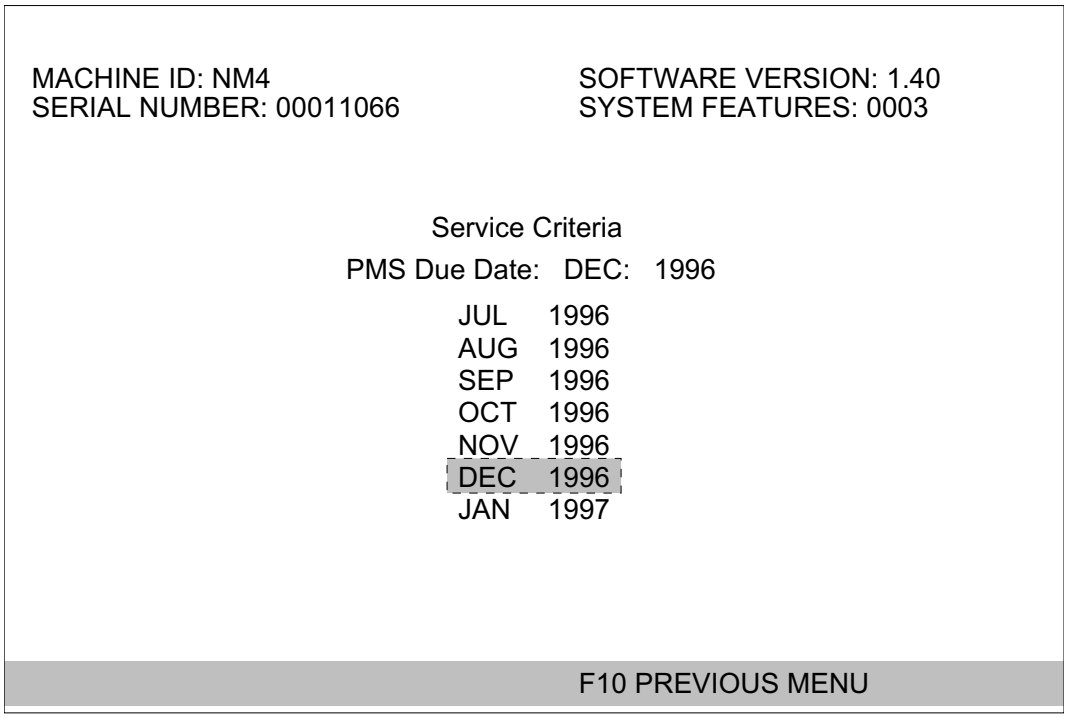
-- To copy the service log to the disk drive in the ORDM or the external PC, press the F1 key on the PC (MONITOR key on the ORDM).

-- Press ESC on the ORDM (F10 on the external PC) to return to the Primary Service Menu. If desired, press ESC (or F10) again to return to the SST Main Menu.

### 7.6.8 Service Criteria

The screen shown in Figure 7-11 indicates the current settings for the due date for periodic machine maintenance, and also allows changing of these settings (except in VIEW mode).

-- At the Primary Service Menu (described earlier) move the cursor at SERVICE CRITERIA and press ENTER.




SV40107

**Figure 7-11: SERVICE CRITERIA SCREEN**

-- Use the up and down keys to scroll to the desired month/year, and press ENTER to make the selection.

-- Press ESC on the ORDM (F10 on the external PC) to return to the Primary Service Menu. If desired, press ESC (or F10) again to return to the SST Main Menu.

### 7.6.9 Service/Test Hardware

The Service/Test Hardware screen (Figure 7-12) displays a menu that allows access to the service functions listed.

-- At the Primary Service Menu (described earlier) move the cursor to SERVICE/TEST HARDWARE and press ENTER.

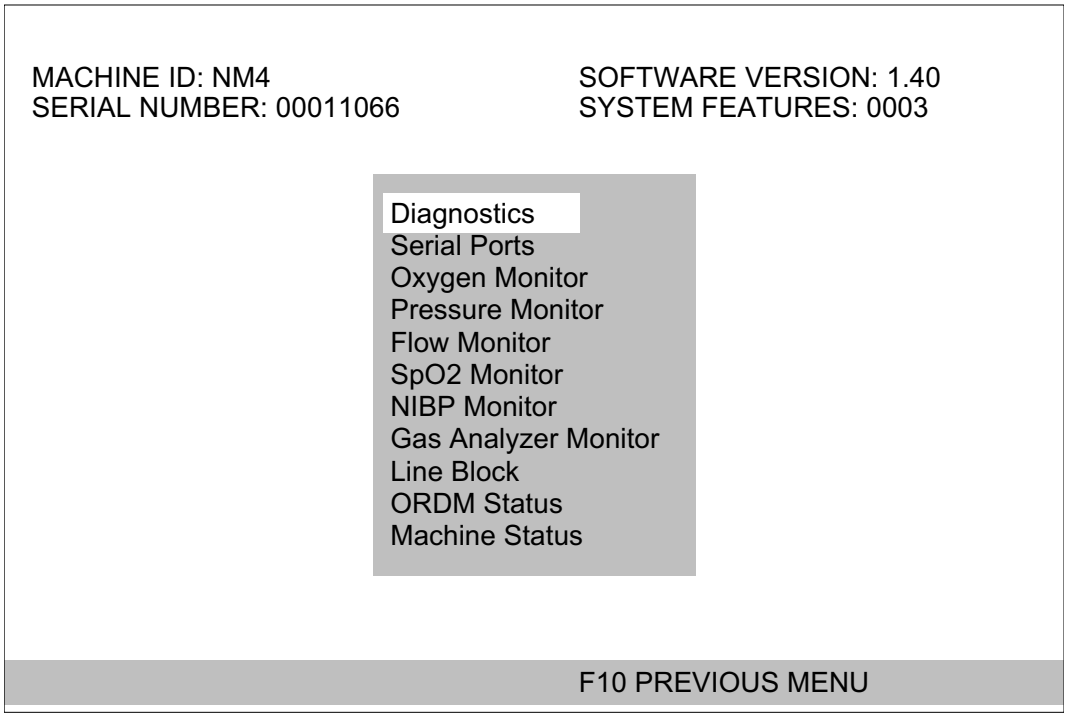



**Figure 7-12: SERVICE/TEST HARDWARE SCREEN**

-- Use the up and down arrows to select the desired sub-screen, and press ENTER.

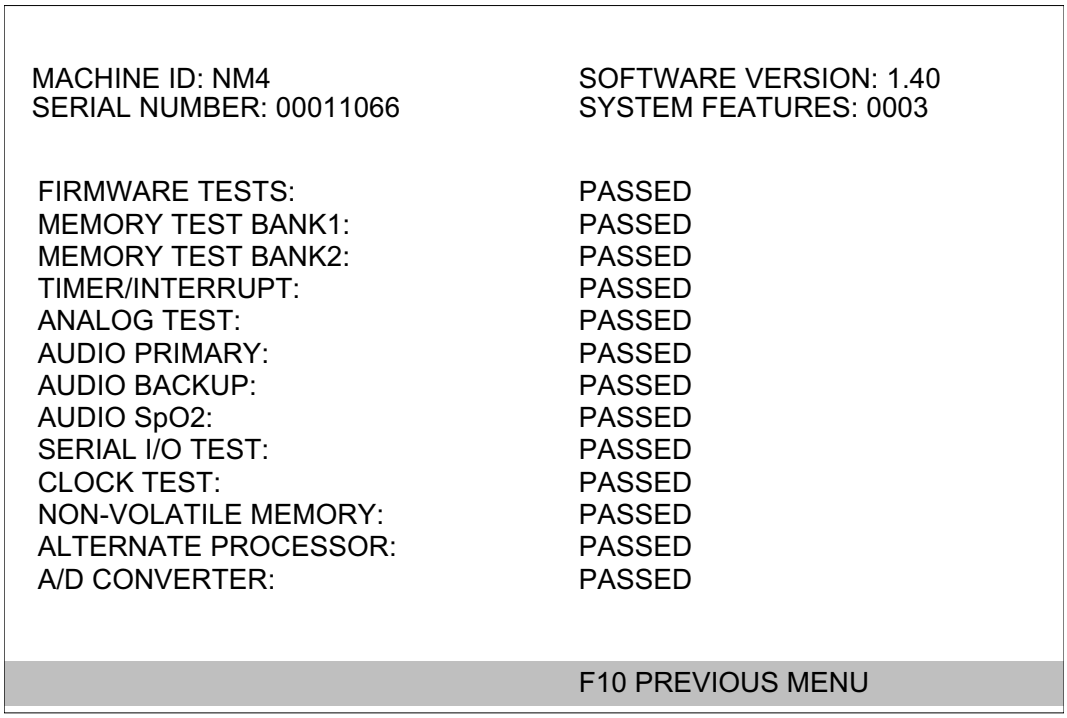
These screens indicate power-up diagnostic and machine status, provide for serial port loopback tests, and also verification and calibration of monitors.

These tests and their associated screens are described on the following pages.

### 7.6.9.1 Diagnostics

The Diagnostics screen shown in Figure 7-13 displays the results of a series of tests performed when the machine is powered up.

-- At the Service/Test Hardware screen (described earlier) move the cursor to DIAGNOSTICS and press ENTER.




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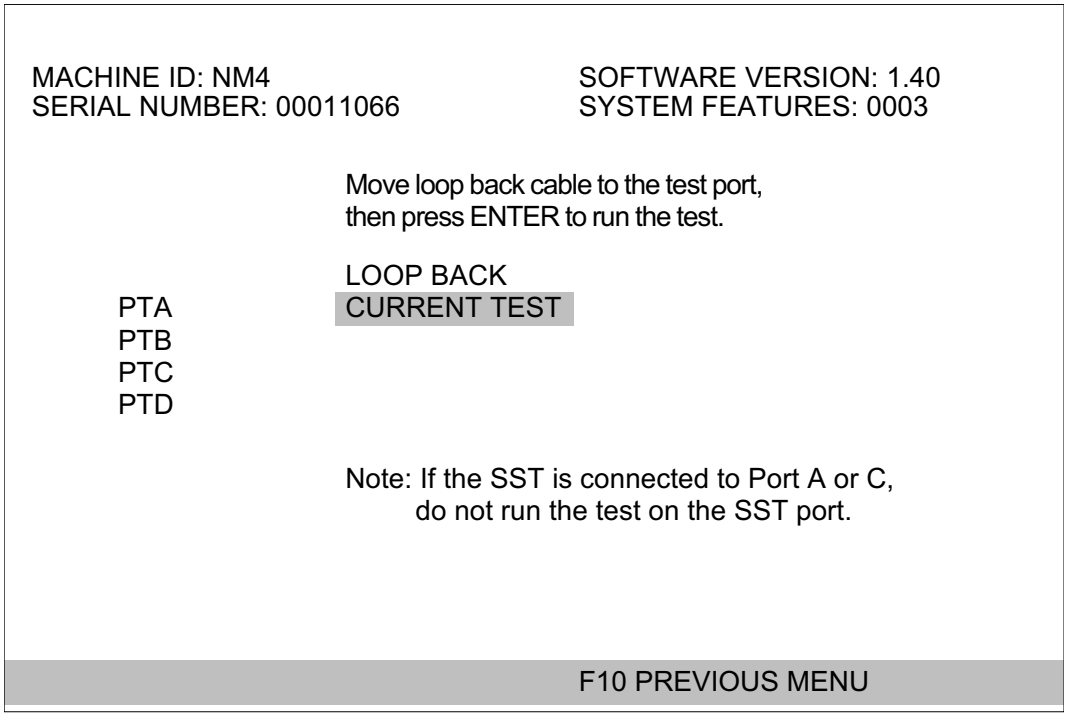
**Figure 7-13: DIAGNOSTICS SCREEN**

-- Press ESC on the ORDM (F10 on the external PC) to return to the Primary Service/Test Hardware screen. If desired, press ESC (or F10) again to return to the Primary Service Menu.

### 7.6.9.2 Serial Ports

-- At the Service/Test Hardware screen (described earlier) move the cursor to SERIAL PORTS and press ENTER.

-- Use the up and down arrows to select Port A, and press ENTER. See Figure 7-14.




SV40110

**Figure 7-14: SERIAL PORTS TEST SCREEN**

-- Remove any cable connected to Port A and insert the loopback test plug (P/N 4112871) into Port A. [Skip Port A test if SST is not running through the ORDM.]

NOTE: One end of the test plug is marked RS232, and the other end is marked RS422. Be sure to insert the end of the test plug that corresponds to the Port A communication interface configuration.

-- Follow the on-screen instructions to perform the Loop Back test on Port A. If the test is successful, the CURRENT TEST message changes to PASSED.

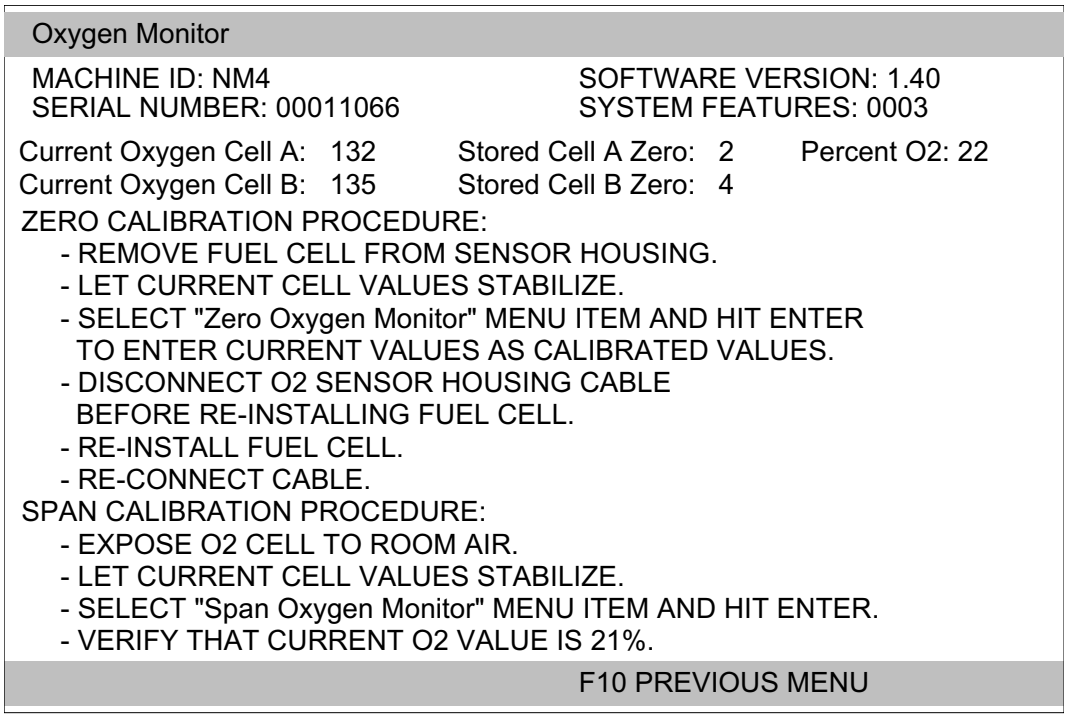
-- Move the test plug to the next port, follow the on-screen instructions and test each port in the same manner.

-- Press ESC on the ORDM (F10 on the external PC) to return to the Service/Test Hardware screen. If desired, press ESC (or F10) again to return to the Primary Service Menu.

### 7.6.9.3 Oxygen Monitor

-- At the Service/Test Hardware screen (described earlier) set the cursor to OXYGEN MONITOR and press ENTER.

The Oxygen Monitor screen shown in Figure 7-15 displays current oxygen cell readings and provides a zero calibration procedure for the machine's oxygen monitor.


Oxygen Monitor
MACHINE ID: NM4
SERIAL NUMBER: 00011066
SOFTWARE VERSION: 1.40
SYSTEM FEATURES: 0003
Current Oxygen Cell A: 132
Current Oxygen Cell B: 135
Stored Cell A Zero: 2
Stored Cell B Zero: 4
Percent O2: 22
ZERO CALIBRATION PROCEDURE:
- REMOVE FUEL CELL FROM SENSOR HOUSING.
- LET CURRENT CELL VALUES STABILIZE.
- SELECT "Zero Oxygen Monitor" MENU ITEM AND HIT ENTER TO ENTER CURRENT VALUES AS CALIBRATED VALUES.
- DISCONNECT O2 SENSOR HOUSING CABLE BEFORE RE-INSTALLING FUEL CELL.
- RE-INSTALL FUEL CELL.
- RE-CONNECT CABLE.
SPAN CALIBRATION PROCEDURE:
- EXPOSE O2 CELL TO ROOM AIR.
- LET CURRENT CELL VALUES STABILIZE.
- SELECT "Span Oxygen Monitor" MENU ITEM AND HIT ENTER.
- VERIFY THAT CURRENT O2 VALUE IS 21%.
F10 PREVIOUS MENU

SV40111

**Figure 7-15: OXYGEN MONITOR SERVICE SCREEN**

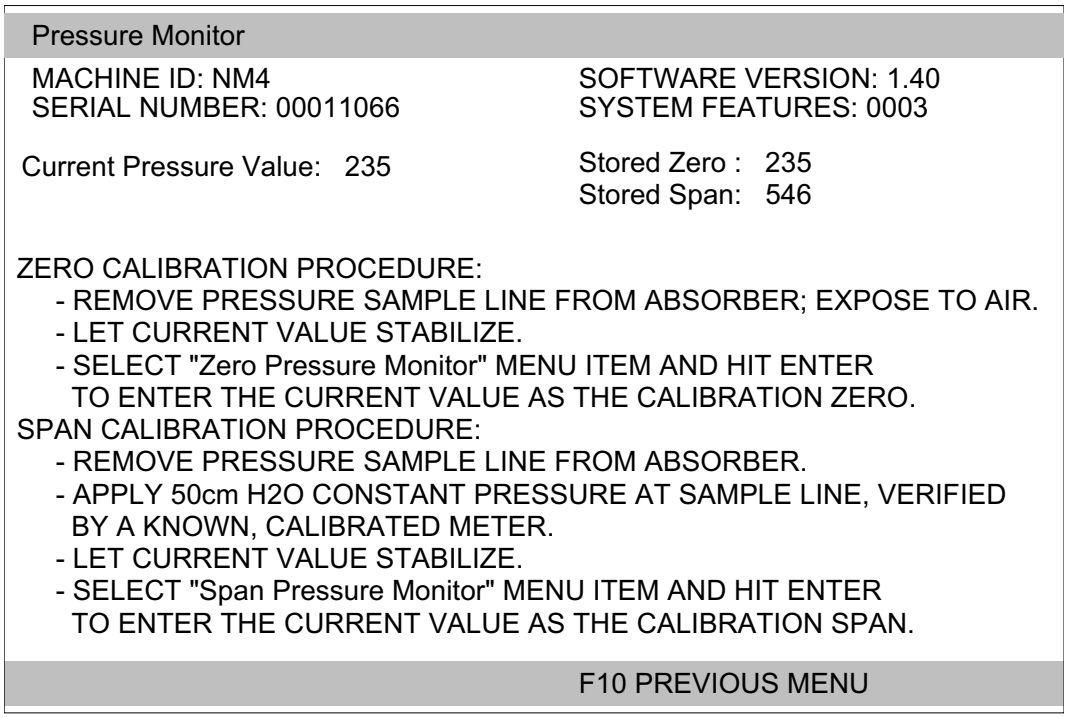
-- Calibration can be performed while in the Service mode by following the on-screen instructions.

-- Press ESC on the ORDM (F10 on the external PC) to return to the Service/Test Hardware screen. If desired, press ESC (or F10) again to return to the Primary Service Menu.

### 7.6.9.4 Pressure Monitor

-- At the Service/Test Hardware screen (described earlier) set the cursor to PRESSURE MONITOR and press ENTER.

The Pressure Monitor screen shown in Figure 7-16 displays the current pressure value and provides zero and span calibration procedures for the machine's pressure monitor.


Pressure Monitor
MACHINE ID: NM4
SERIAL NUMBER: 00011066
SOFTWARE VERSION: 1.40
SYSTEM FEATURES: 0003
Current Pressure Value: 235
Stored Zero : 235
Stored Span: 546
ZERO CALIBRATION PROCEDURE:
- REMOVE PRESSURE SAMPLE LINE FROM ABSORBER; EXPOSE TO AIR.
- LET CURRENT VALUE STABILIZE.
- SELECT "Zero Pressure Monitor" MENU ITEM AND HIT ENTER TO ENTER THE CURRENT VALUE AS THE CALIBRATION ZERO.
SPAN CALIBRATION PROCEDURE:
- REMOVE PRESSURE SAMPLE LINE FROM ABSORBER.
- APPLY 50cm H2O CONSTANT PRESSURE AT SAMPLE LINE, VERIFIED BY A KNOWN, CALIBRATED METER.
- LET CURRENT VALUE STABILIZE.
- SELECT "Span Pressure Monitor" MENU ITEM AND HIT ENTER TO ENTER THE CURRENT VALUE AS THE CALIBRATION SPAN.
F10 PREVIOUS MENU

SV40112

**Figure 7-16: PRESSURE MONITOR SERVICE SCREEN**

-- Calibration can be performed while in the Service mode by following the on-screen instructions.

-- Press ESC on the ORDM (F10 on the external PC) to return to the Service/Test Hardware screen. If desired, press ESC (or F10) again to return to the Primary Service Menu.

### 7.6.9.5 Flow Monitor

The Flow Monitor screen shown in Figure 7-17 displays the current respiratory flow value and provides zero and span calibration procedure for the machine's respiratory flow monitor.

-- At the Service/Test Hardware screen (described earlier) move the cursor to FLOW MONITOR and press ENTER.

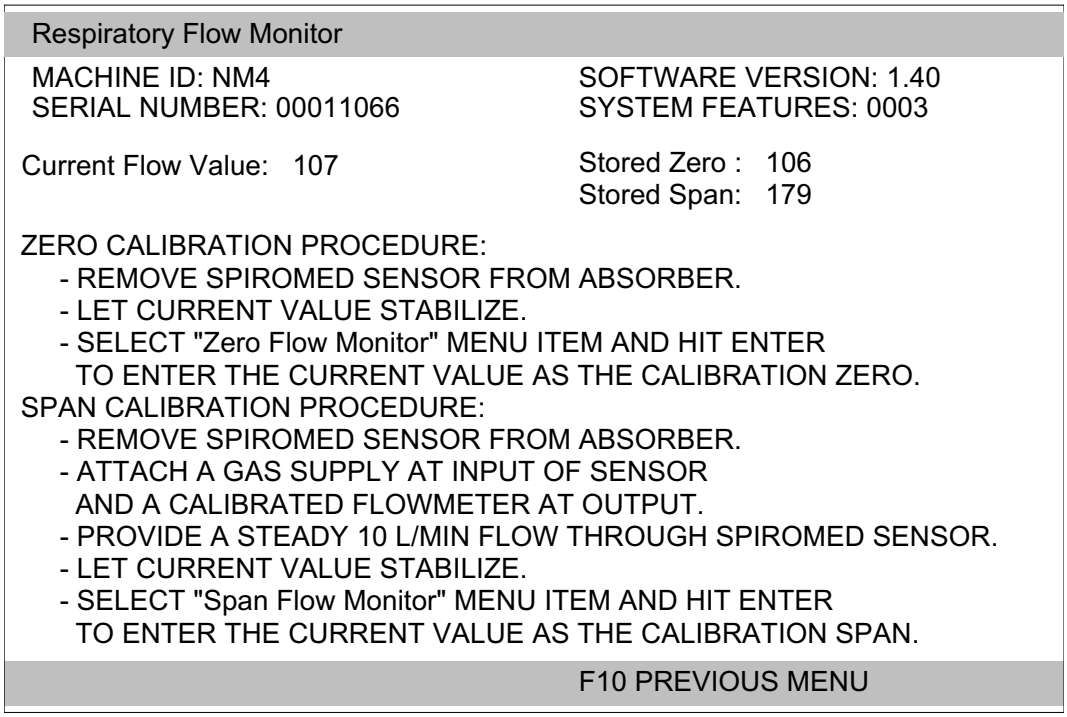

Respiratory Flow Monitor
MACHINE ID: NM4
SERIAL NUMBER: 00011066
SOFTWARE VERSION: 1.40
SYSTEM FEATURES: 0003
Current Flow Value: 107
Stored Zero : 106
Stored Span: 179
ZERO CALIBRATION PROCEDURE:
- REMOVE SPIROMED SENSOR FROM ABSORBER.
- LET CURRENT VALUE STABILIZE.
- SELECT "Zero Flow Monitor" MENU ITEM AND HIT ENTER
TO ENTER THE CURRENT VALUE AS THE CALIBRATION ZERO.
SPAN CALIBRATION PROCEDURE:
- REMOVE SPIROMED SENSOR FROM ABSORBER.
- ATTACH A GAS SUPPLY AT INPUT OF SENSOR
AND A CALIBRATED FLOWMETER AT OUTPUT.
- PROVIDE A STEADY 10 L/MIN FLOW THROUGH SPIROMED SENSOR.
- LET CURRENT VALUE STABILIZE.
- SELECT "Span Flow Monitor" MENU ITEM AND HIT ENTER
TO ENTER THE CURRENT VALUE AS THE CALIBRATION SPAN.
F10 PREVIOUS MENU
SV40113

**Figure 7-17: RESPIRATORY FLOW MONITOR SERVICE SCREEN**

-- Calibration can be performed while in the Service mode by following the on-screen instructions.

-- Press ESC on the ORDM (F10 on the external PC) to return to the Service/Test Hardware screen. If desired, press ESC (or F10) again to return to the Primary Service Menu.

### 7.6.9.6 $SpO_2$ Monitor

The $SpO_2$ Monitor screen shown in Figure 7-18 displays current $SpO_2$ and current Pulse values reported by the machine's $SpO_2$ monitor.

-- At the Service/Test Hardware screen (described earlier) move the cursor to SPO2 MONITOR and press ENTER.

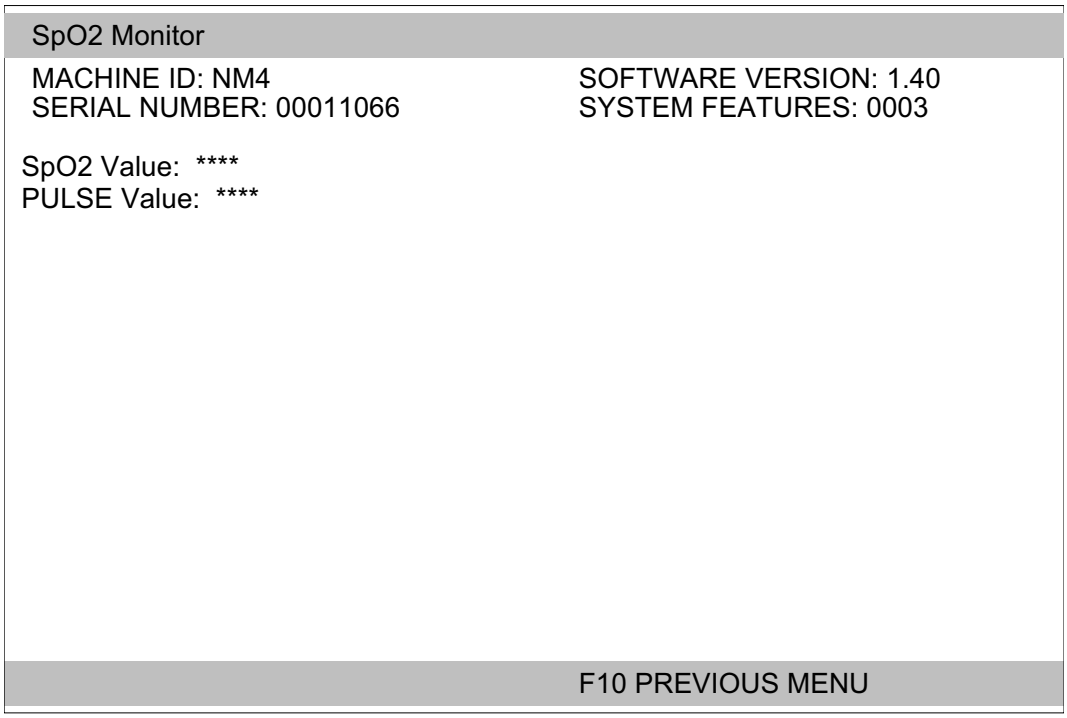



**Figure 7-18: $SpO_2$ MONITOR SERVICE SCREEN**

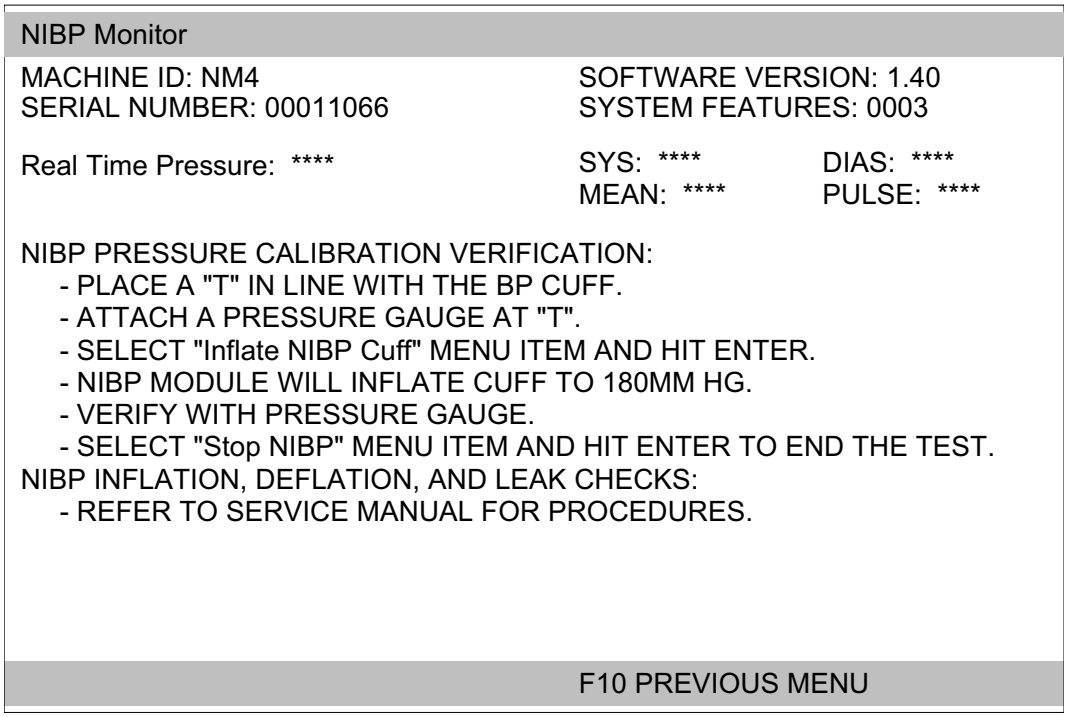
-- Refer to Section 5 of this manual for calibration verification procedures.

-- Press ESC on the ORDM (F10 on the external PC) to return to the Service/Test Hardware screen. If desired, press ESC (or F10) again to return to the Primary Service Menu.

### 7.6.9.7 NIBP Monitor

The NIBP Monitor screen shown in Figure 7-19 displays current pressure readings and provides a verification procedure for cuff inflation pressure.

-- At the Service/Test Hardware screen (described earlier) move the cursor to NIBP MONITOR and press ENTER.


NIBP Monitor
MACHINE ID: NM4
SERIAL NUMBER: 00011066
SOFTWARE VERSION: 1.40
SYSTEM FEATURES: 0003
Real Time Pressure: ****
SYS: ****
DIAS: ****
MEAN: ****
PULSE: ****
NIBP PRESSURE CALIBRATION VERIFICATION:
- PLACE A "T" IN LINE WITH THE BP CUFF.
- ATTACH A PRESSURE GAUGE AT "T".
- SELECT "Inflate NIBP Cuff" MENU ITEM AND HIT ENTER.
- NIBP MODULE WILL INFLATE CUFF TO 180MM HG.
- VERIFY WITH PRESSURE GAUGE.
- SELECT "Stop NIBP" MENU ITEM AND HIT ENTER TO END THE TEST.
NIBP INFLATION, DEFLATION, AND LEAK CHECKS:
- REFER TO SERVICE MANUAL FOR PROCEDURES.
F10 PREVIOUS MENU

SV40115

**Figure 7-19: NIBP MONITOR SERVICE SCREEN**

-- Calibration verification can be performed while in the Service mode by following the on-screen instructions.

-- Press ESC on the ORDM (F10 on the external PC) to return to the Service/Test Hardware screen. If desired, press ESC (or F10) again to return to the Primary Service Menu.

### 7.6.9.8 Gas Analyzer Monitor

The Gas Analyzer Monitor screen shown in Figure 7-20 displays current gas analysis and provides a span calibration procedure for the machine's multispec monitor.

-- At the Service/Test Hardware screen (described earlier) move the cursor to GAS ANALYZER MONITOR and press ENTER.

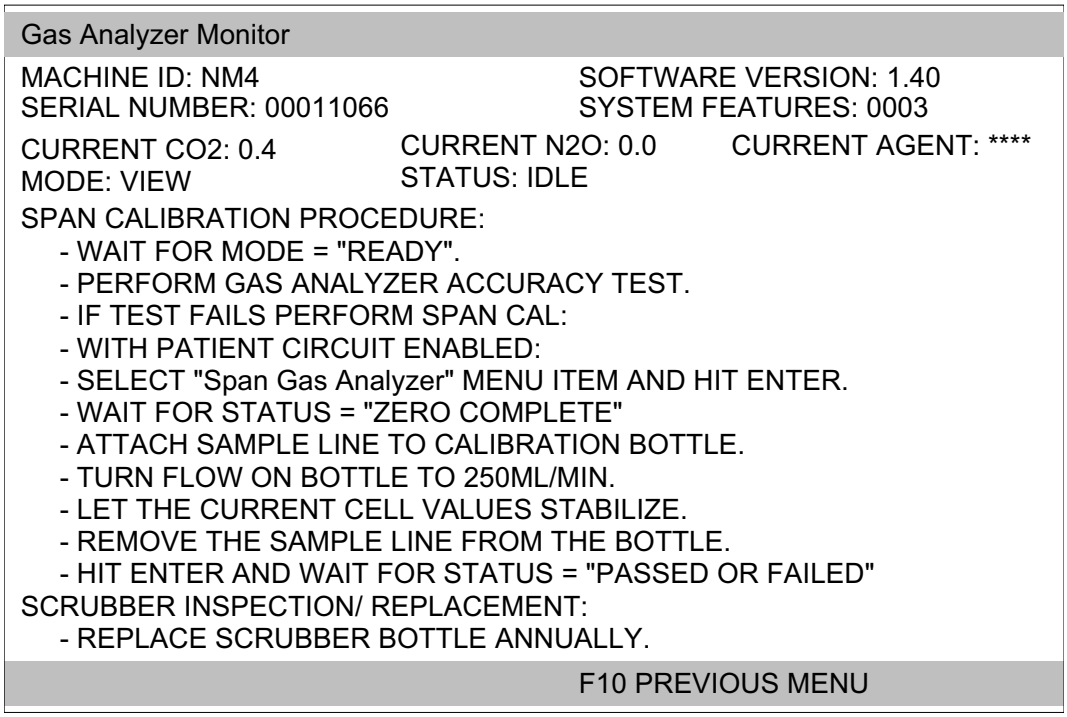

Gas Analyzer Monitor
MACHINE ID: NM4
SERIAL NUMBER: 00011066
SOFTWARE VERSION: 1.40
SYSTEM FEATURES: 0003
CURRENT CO2: 0.4
CURRENT N2O: 0.0
CURRENT AGENT: ****
MODE: VIEW
STATUS: IDLE
SPAN CALIBRATION PROCEDURE:
- WAIT FOR MODE = "READY".
- PERFORM GAS ANALYZER ACCURACY TEST.
- IF TEST FAILS PERFORM SPAN CAL:
- WITH PATIENT CIRCUIT ENABLED:
- SELECT "Span Gas Analyzer" MENU ITEM AND HIT ENTER.
- WAIT FOR STATUS = "ZERO COMPLETE"
- ATTACH SAMPLE LINE TO CALIBRATION BOTTLE.
- TURN FLOW ON BOTTLE TO 250ML/MIN.
- LET THE CURRENT CELL VALUES STABILIZE.
- REMOVE THE SAMPLE LINE FROM THE BOTTLE.
- HIT ENTER AND WAIT FOR STATUS = "PASSED OR FAILED"
SCRUBBER INSPECTION/ REPLACEMENT:
- REPLACE SCRUBBER BOTTLE ANNUALLY.
F10 PREVIOUS MENU
SV40116

**Figure 7-20: GAS ANALYZER MONITOR SERVICE SCREEN**

-- Calibration can be performed while in the Service mode by following the on-screen instructions. A more detailed description of calibration connections is provided in Section 5 of this manual.

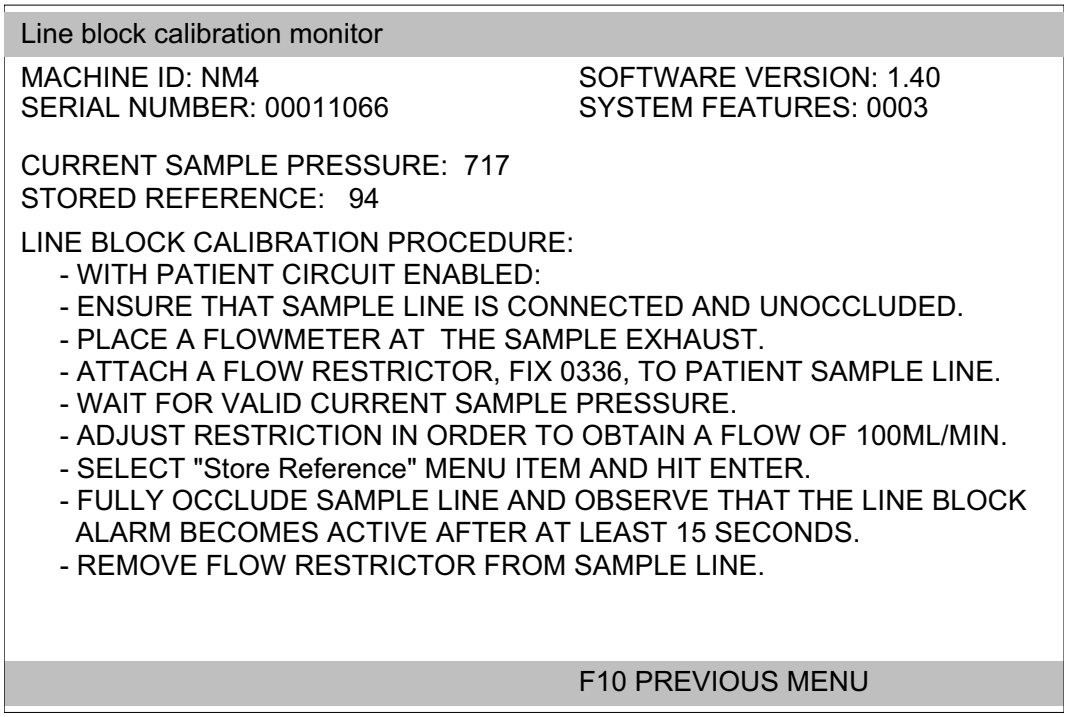
NOTE: The scrubber inspection message does not appear on machines equipped with an model 4610 gas analyzer.

-- Press ESC on the ORDM (F10 on the external PC) to return to the Service/Test Hardware screen. If desired, press ESC (or F10) again to return to the Primary Service Menu.

### 7.6.9.9 Line Block

The Line Block screen shown in Figure 7-21 displays current sample line pressure and provides a calibration procedure for the machine's oxygen monitor.

-- At the Service/Test Hardware screen (described earlier) move the cursor to LINE BLOCK and press ENTER.


Line block calibration monitor
MACHINE ID: NM4
SERIAL NUMBER: 00011066
SOFTWARE VERSION: 1.40
SYSTEM FEATURES: 0003
CURRENT SAMPLE PRESSURE: 717
STORED REFERENCE: 94
LINE BLOCK CALIBRATION PROCEDURE:
- WITH PATIENT CIRCUIT ENABLED:
- ENSURE THAT SAMPLE LINE IS CONNECTED AND UNOCCLUDED.
- PLACE A FLOWMETER AT THE SAMPLE EXHAUST.
- ATTACH A FLOW RESTRICTOR, FIX 0336, TO PATIENT SAMPLE LINE.
- WAIT FOR VALID CURRENT SAMPLE PRESSURE.
- ADJUST RESTRICTION IN ORDER TO OBTAIN A FLOW OF 100ML/MIN.
- SELECT "Store Reference" MENU ITEM AND HIT ENTER.
- FULLY OCCLUDE SAMPLE LINE AND OBSERVE THAT THE LINE BLOCK ALARM BECOMES ACTIVE AFTER AT LEAST 15 SECONDS.
- REMOVE FLOW RESTRICTOR FROM SAMPLE LINE.
F10 PREVIOUS MENU

SV40117

**Figure 7-21: LINE BLOCK SERVICE SCREEN**

-- Calibration and alarm test can be performed while in the Service mode by following the on-screen instructions.

-- Press ESC on the ORDM (F10 on the external PC) to return to the Service/Test Hardware screen. If desired, press ESC (or F10) again to return to the Primary Service Menu.

### 7.6.9.10 ORDM Status

The ORDM Status screen shown in Figure 7-22 displays the current status of the machine's remote display and printer relays.

-- At the Service/Test Hardware screen (described earlier) move the cursor to ORDM STATUS and press ENTER.

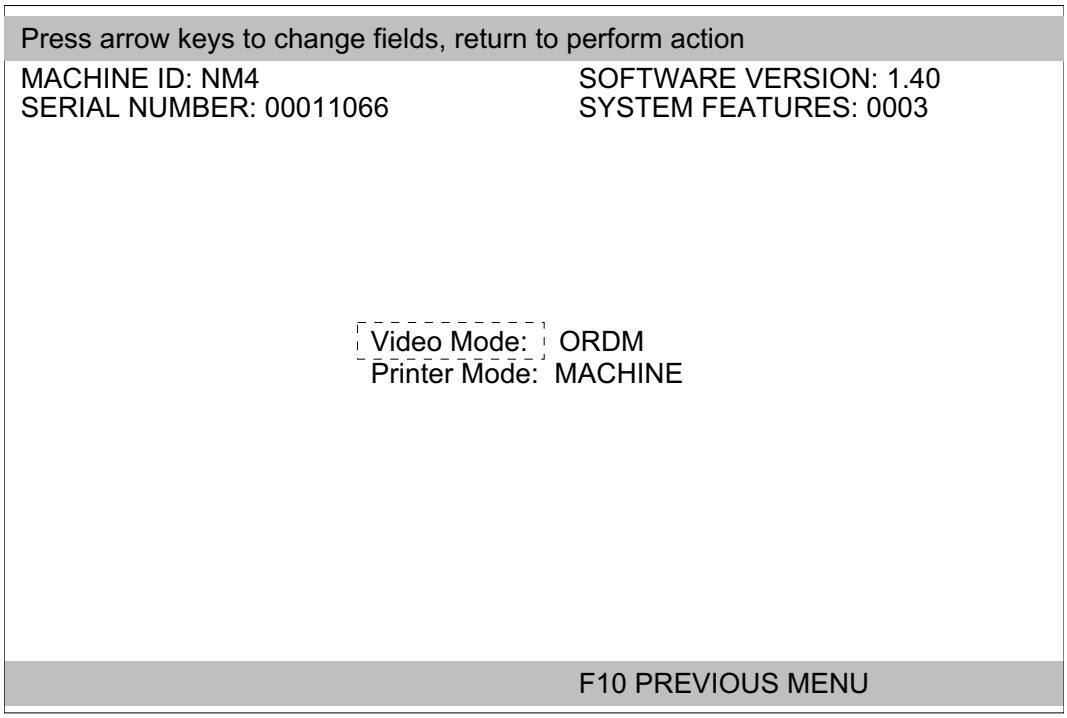



**Figure 7-22: ORDM STATUS SCREEN**

-- The relays can be switched while in the Service mode as follows:

Use the up or down keys to select Video Mode or Printer Mode, and press ENTER. Select ORDM or MACHINE and press ENTER again.

For the Video Mode, when ORDM is selected, the remote display will show ORDM functions. When MACHINE is selected, the remote display shows NM4 data and alarms.

For the Printer Mode, when ORDM is selected, the machine's external printer port is connected to the ORDM.

-- Press ESC on the ORDM (F10 on the external PC) to return to the Service/Test Hardware screen. If desired, press ESC (or F10) again to return to the Primary Service Menu.

### 7.6.9.11 Machine Status

The Machine Status screen shown in Figure 7-23 displays the current status of those machine functions listed.

-- At the Service/Test Hardware screen (described earlier) move the cursor to MACHINE STATUS and press ENTER.

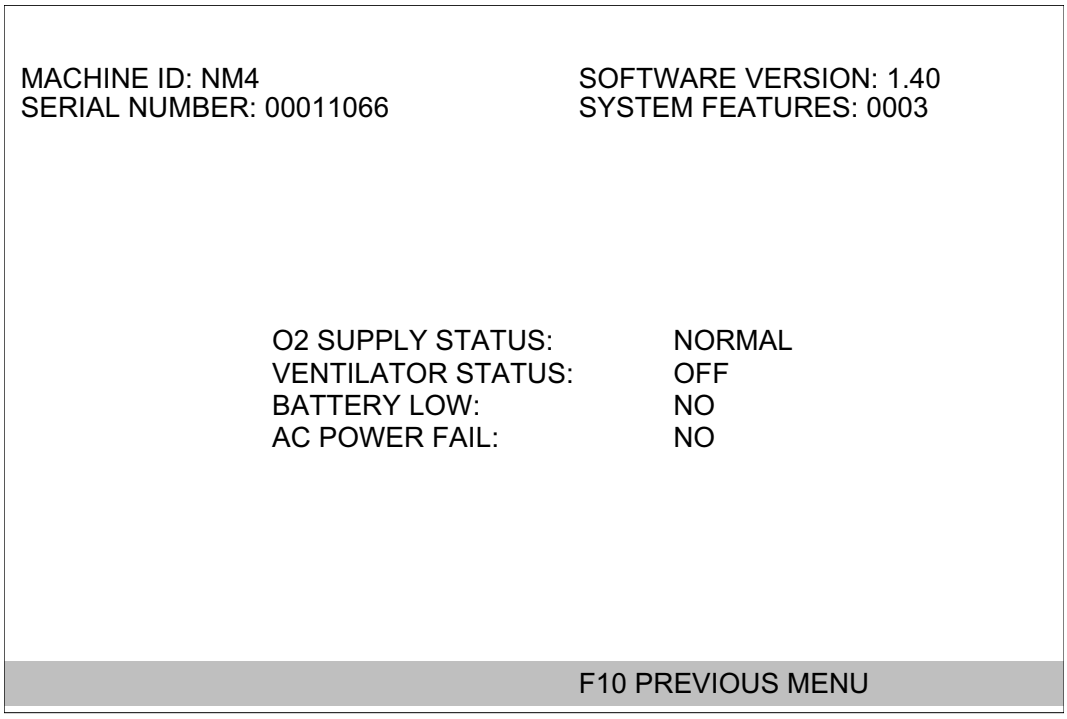



**Figure 7-23: MACHINE STATUS SCREEN**

-- Press ESC on the ORDM (F10 on the external PC) to return to the Service/Test Hardware screen. If desired, press ESC (or F10) again to return to the Primary Service Menu.

### 7.6.10 Save/Restore Calibration Constants

This screen allows all monitor calibration settings to be copied to the ORDM disk drive, or to the external PC disk drive. These settings can then be restored from the disk to the machine following any hardware replacement.

-- At the Primary Service Menu (described earlier) move the cursor to SAVE/RESTORE CONSTANTS and press ENTER.

-- Move the cursor with the up or down keys to the desired function, and press ENTER.

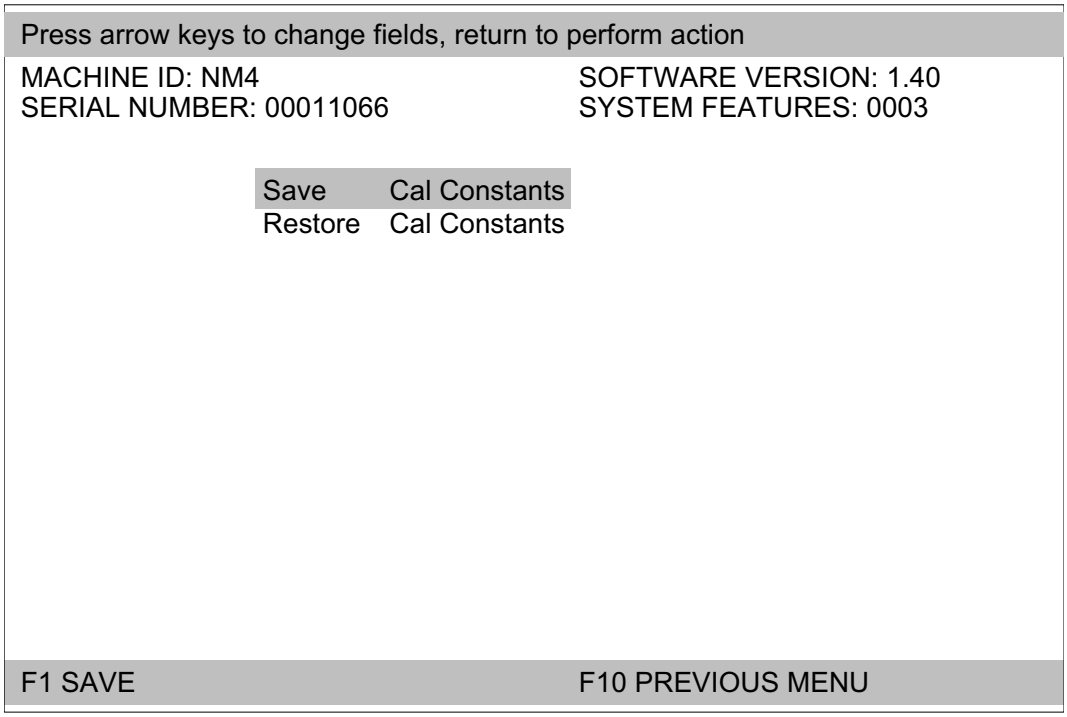


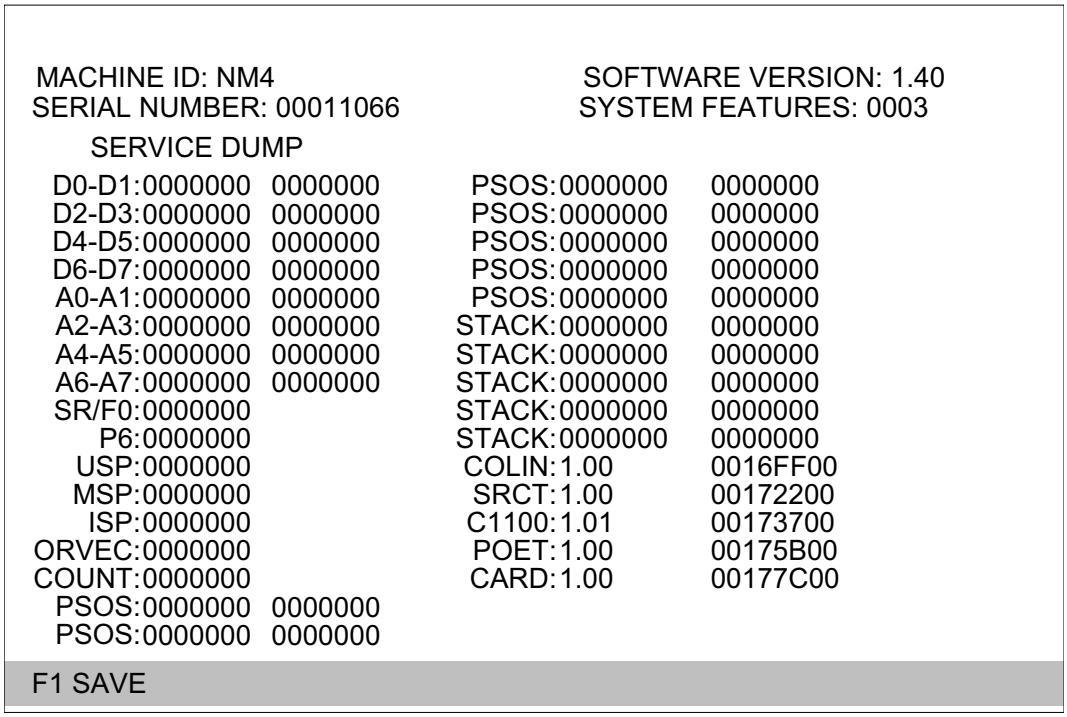

**Figure 7-24: SAVE/RESTORE CALIBRATION CONSTANTS SCREEN**

-- Press ESC on the ORDM (F10 on the external PC) to return to the Primary Service Menu. If desired, press ESC (or F10) again to return to the SST Main Menu.

### 7.6.11 Service Dump

This screen displays processor address and register debug information. This screen should be checked whenever the machine is serviced, and any non-zero codes that appear should be recorded and reported to the NAD Engineering Department.

-- At the Primary Service Menu (described earlier) move the cursor to SERVICE DUMP and press ENTER.




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**Figure 7-25: SERVICE DUMP SCREEN**

-- Press ESC on the ORDM (F10 on the external PC) to return to the Primary Service Menu. If desired, press ESC (or F10) again to return to the SST Main Menu.

### 7.6.12 Template Manager

This screen allows access to templates for viewing or deleting them while in a service mode.

-- At the Primary Service Menu (described earlier) move the cursor to TEMPLATE MANAGER and press ENTER.

-- Move the cursor with the up or down keys to the desired template and press ENTER.

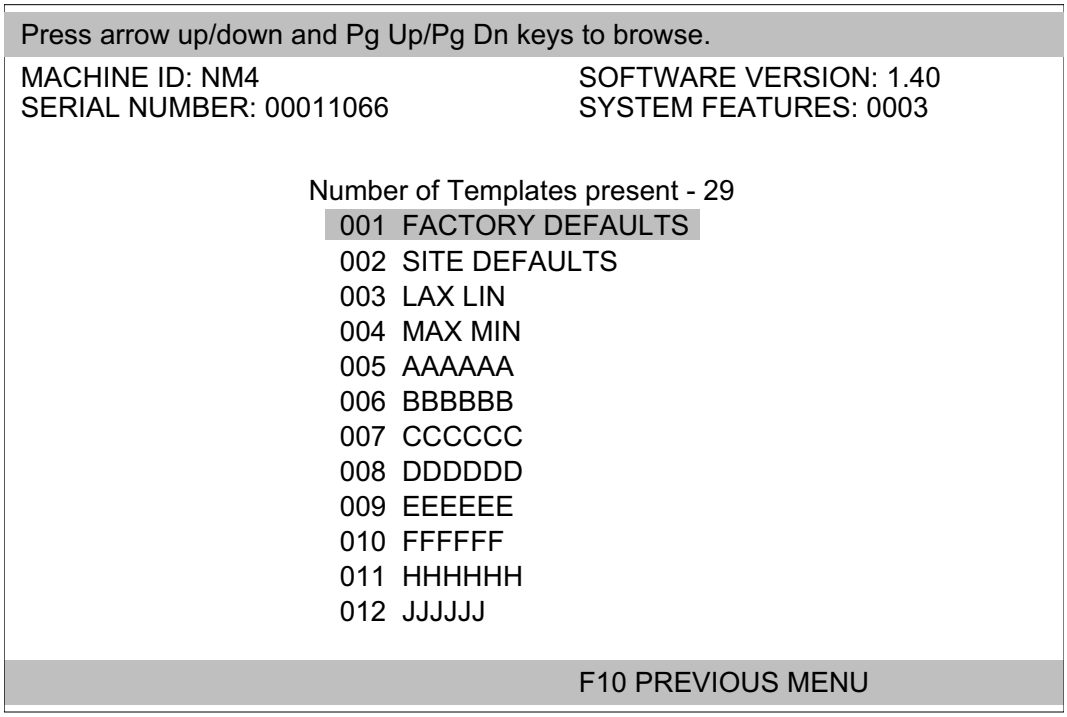



**Figure 7-26: TEMPLATE MANAGER SCREEN**

-- Press ESC on the ORDM (F10 on the external PC) to return to the Primary Service Menu. If desired, press ESC (or F10) again to return to the SST Main Menu.

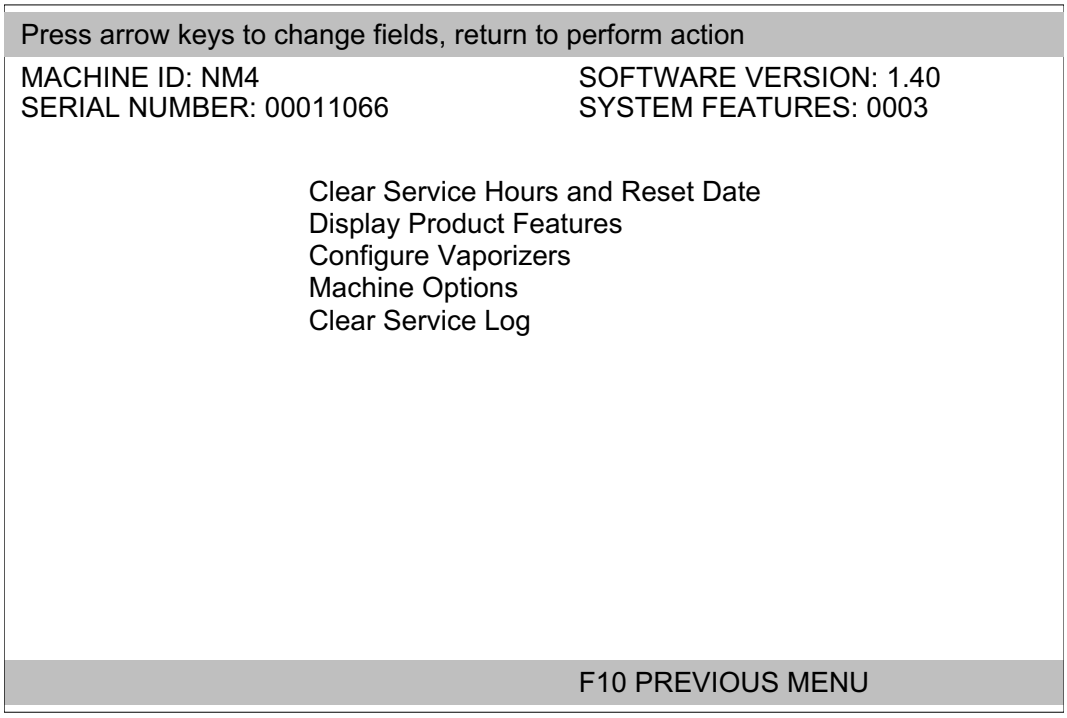
### 7.6.13 Secondary Service Screen

This screen allows access to the functions shown in Figure 7-27.

WARNING: These functions should only be accessed by an authorized Draeger Medical, Inc. Technical Service Representative. Improper access to certain functions may cause important service data to be lost.

-- At the Primary Service Menu (described earlier) select the SERV access level and enter your ID.

-- Press ALT H on the ORDM keyboard, then type in **2 5 6**, and press ENTER to display the secondary service screen.




SV40123

**Figure 7-27: SECONDARY SERVICE SCREEN**

-- Press ESC on the ORDM (F10 on the external PC) to return to the Primary Service Menu. If desired, press ESC (or F10) again to return to the SST Main Menu.

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## 8.0 Spare and Replacement Parts

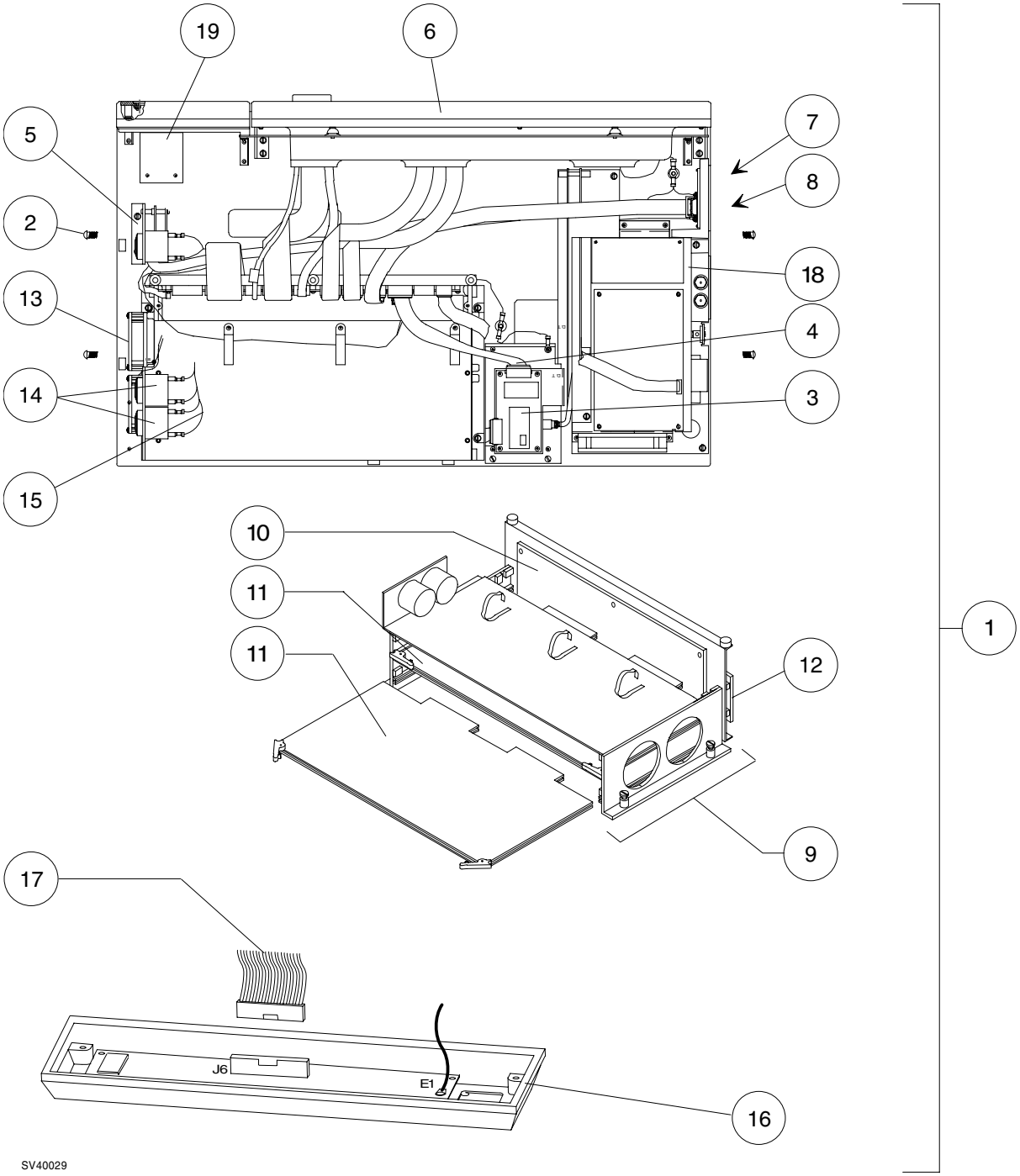
Part numbers for field-replaceable items on the NARKOMED 4 anesthesia system are listed on the following pages, along with part numbers for related hardware and cables.

The item numbers are keyed to the accompanying illustrations to aid in identifying the item and its location.

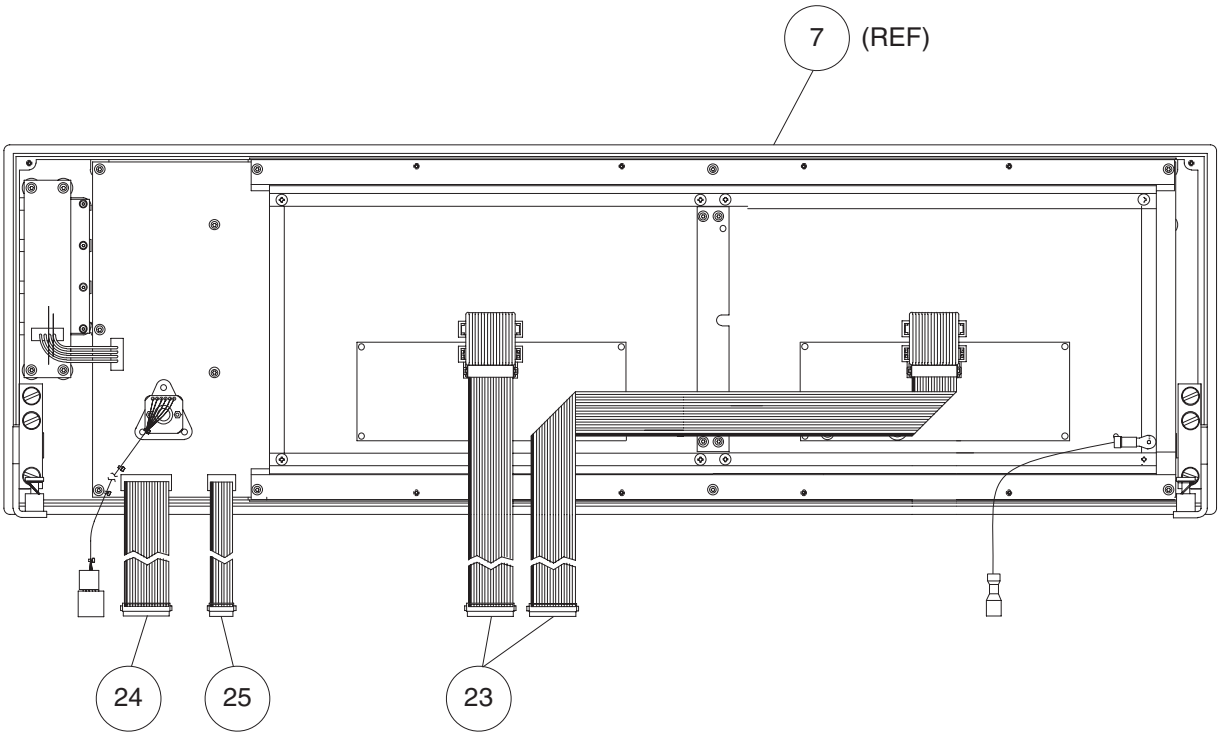
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## SPARE AND REPLACEMENT PARTS (continued) NM4



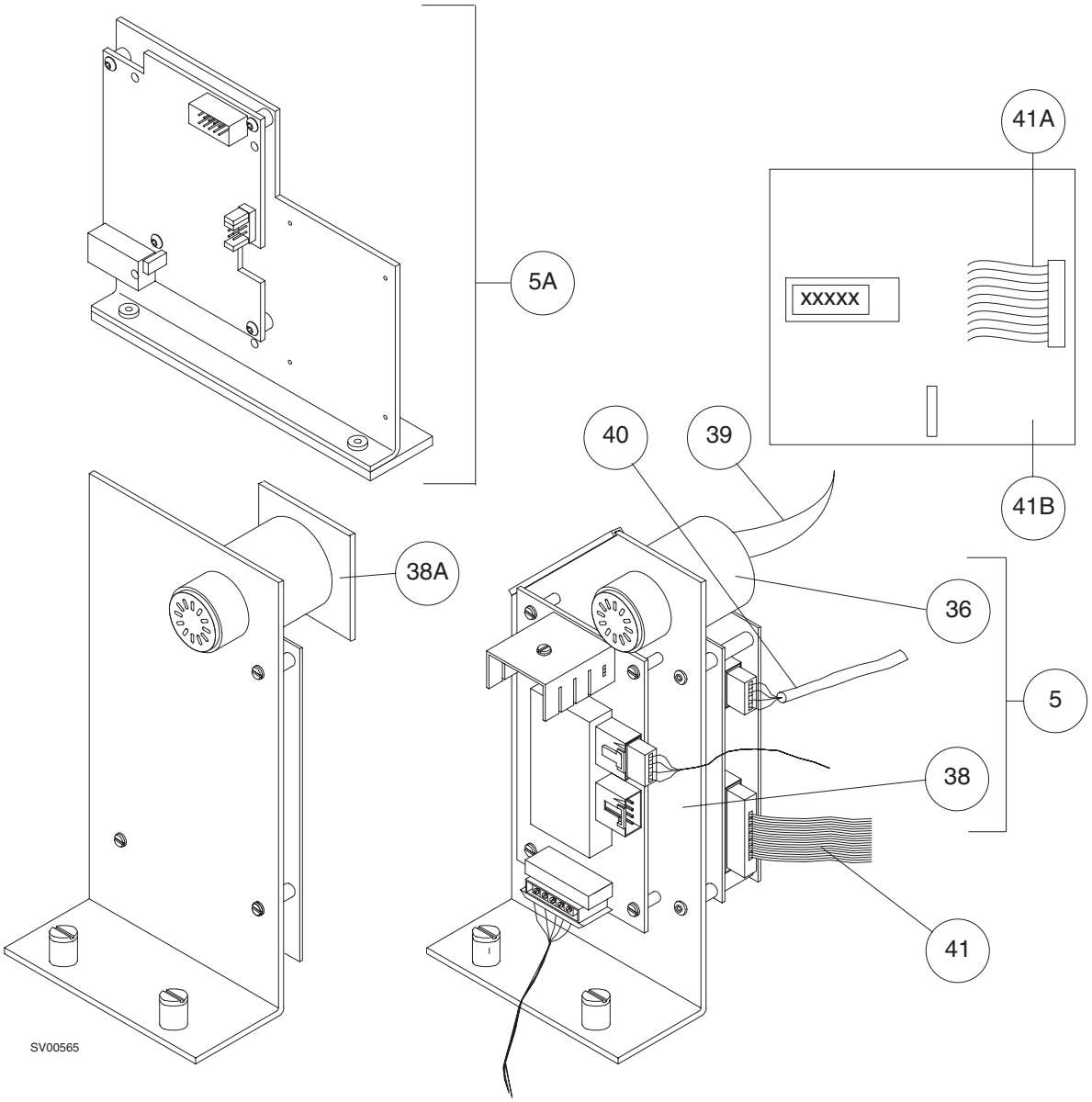
| ITEM | DESCRIPTION | PART NUMBER |
|---|---|---|
| 1 | Monitor Chassis, Complete Assembly (supersedes 4111327) | 4112114 |
| 2 | Screw, Monitor Chassis Cover (8x) | HW09003 |
| 3 | NIBP Assembly (Supersedes 4111101) | 4112249 |
| | BP Module | 4109794 |
| 4 | Cable, NIBP to Backplane (Supersedes 4111322) | 4112222 |
| | NIBP Upgrade Kit | S010160 |
| 5 | Pulse Oximeter Asm | (Related parts listed on a subsequent page) |
| 6 | Front Bezel Assembly (Compatible w/ all Processor Boards) | 4111338 |
| | Service Exchange | SE4111338 |
| | Front Bezel Assembly (Compatible w/ Processor Boards Rev. M and later) | 4111728 |
| | Service Exchange | SE4111728 |
| | (Field replaceable sub-assemblies are listed on a subsequent page.) | |
| 7 | Panel Assembly, Remote Display Connector (Incl. Cable to Backplane) | 4111319 |
| 8 | Panel Assembly, Datagrip Connector (Incl. Cable to Backplane) | 4112171 |
| 9 | Card Cage Assembly | 4111328 |
| | Later design including $SpO_2$ speaker & amp. | 4113100 |
| 10 | Backplane Circuit Board Assembly (not interchangeable) | 4110699 |
| | Service Exchange | SE4110699 |
| | Backplane Circuit Board Assembly (Later Models)(interchangeable w/4112303) | 4111881 |
| | Service Exchange | SE4111881 |
| | Superseded by (interchangeable w/4111881) | 4112303 |
| | Service Exchange | SE4112303 |
| 11 | Processor Board (2x) old #: 4110331, new #: | 4113552 |
| | Service Exchange | SE4110331 |
| | NOTE: Boards below Rev. M are compatible with Bezel Asm 4111338 only. Boards Rev. M & later are compatible with Bezel Asms 4111338 & 4111728. | |
| 12 | Datagrip PCB Assembly | 4112027 |
| | Datagrip PCB to Backplane Cable | 4112170 |
| 13 | Fan Assembly (2x) (Compatible with Backplane Asm 4111881 & later) | 4111732 |
| | Fan (2x) | 4111105 |
| | Connector Shell, Fan (Compatible with Backplane Asm 4110699) | 4108991 |
| | Terminal (4x), Fan Wire Connector | 4108819 |
| 14 | Speaker (2x) | 4106335 |
| 15 | Wire Harness, Speaker to Backplane (2x) | 4111094 |
| 16 | Serial Interface Port Assembly (parts breakdown listed on a subsequent page) | 4111317 |
| | Service Exchange | SE4111317 |
| 17 | Cable, Serial Interface to Backplane | 4111326 |
| 18 | M'spec Analyzer Model 4600 (Upgrade to 4112181: use P/N S010217) | |
| | Model 4610 (Parts breakdown listed on a subsequent page) | 4112181 |
| | Service Exchange | SE4112181 |
| 19 | Printer Assembly | 4111422 |
| | Printer (Early Models) | 4111129 |
| | Service Exchange | SE4111129 |
| | Printer (Later Models) | 4112048 |
| | Service Exchange | SE4112048 |
| | Printer Mounting Bracket | 4111132 |
| | Cable, Printer to Backplane (Compatible with Backplane Asm 4110699) | 4111418 |
| | Cable, Printer to Backplane (Compatible with Backplane Asm 4111881) | 4111874 |
| | Roller for Model 4111129 | vendor # 620-21098 |
| | Roller for Model 4112048 | vendor # 600-06012-82 |
| | Chart Paper, Roll | 4110335 |



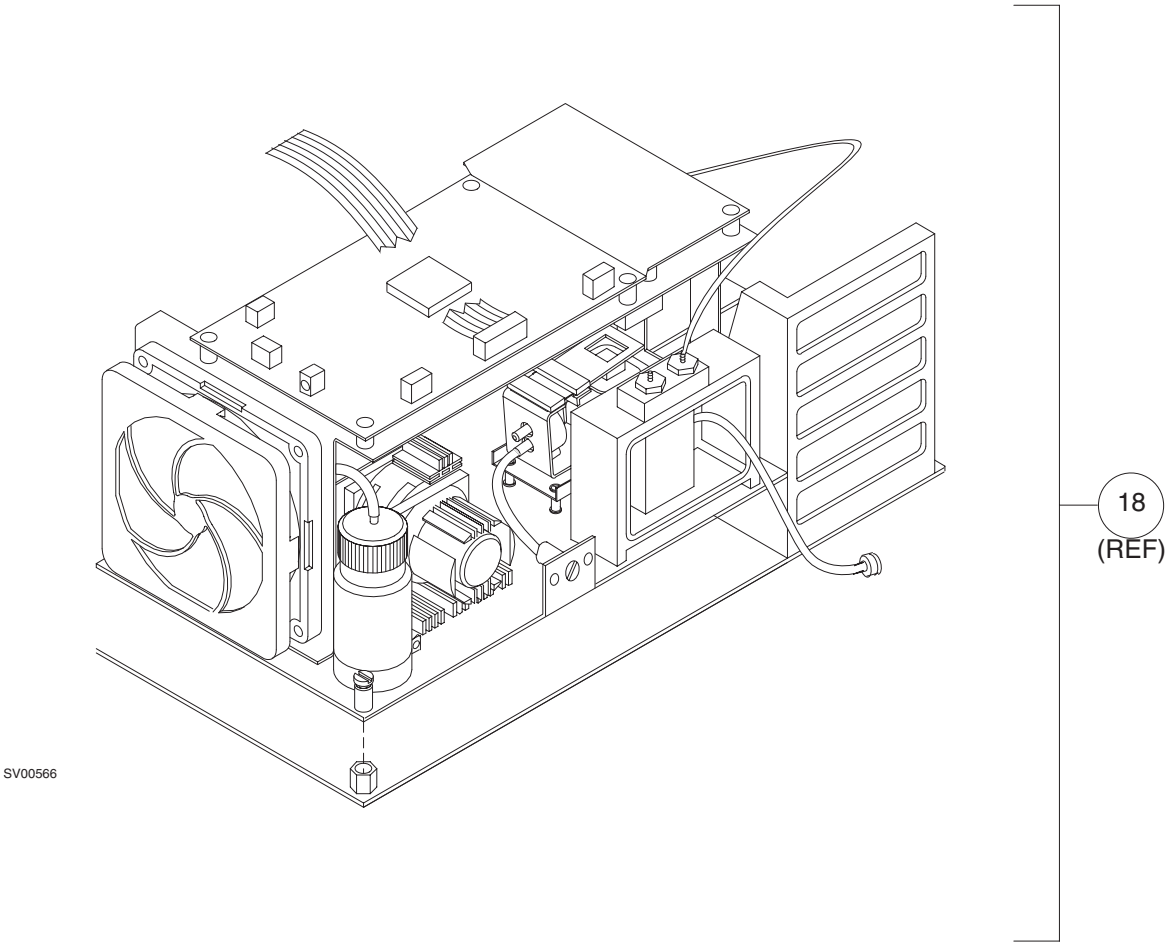

REAR VIEW OF BEZEL ASSEMBLY WITH COVER REMOVED

| ITEM | DESCRIPTION | PART NUMBER |
|---|---|---|
| 7 (Ref.) | Front Bezel Assembly | 4111338 |
| | Later Replaced by | 4111728 |
| 20 | Deleted | |
| 21 | Deleted | |
| 22 | Deleted | |
| 23 | Cable, Display Panel to Backplane (2x) | 4111323 |
| 24 | Cable, 26 Cond., Touch Panel to Backplane | 4111347 |
| 25 | Cable, 10 Cond., Touch Panel to Backplane | 4111348 |
| 26 | Deleted | |
| 27 | Deleted | |
| 28 | Deleted | |
| 29 | Deleted | |
| 30 | Deleted | |

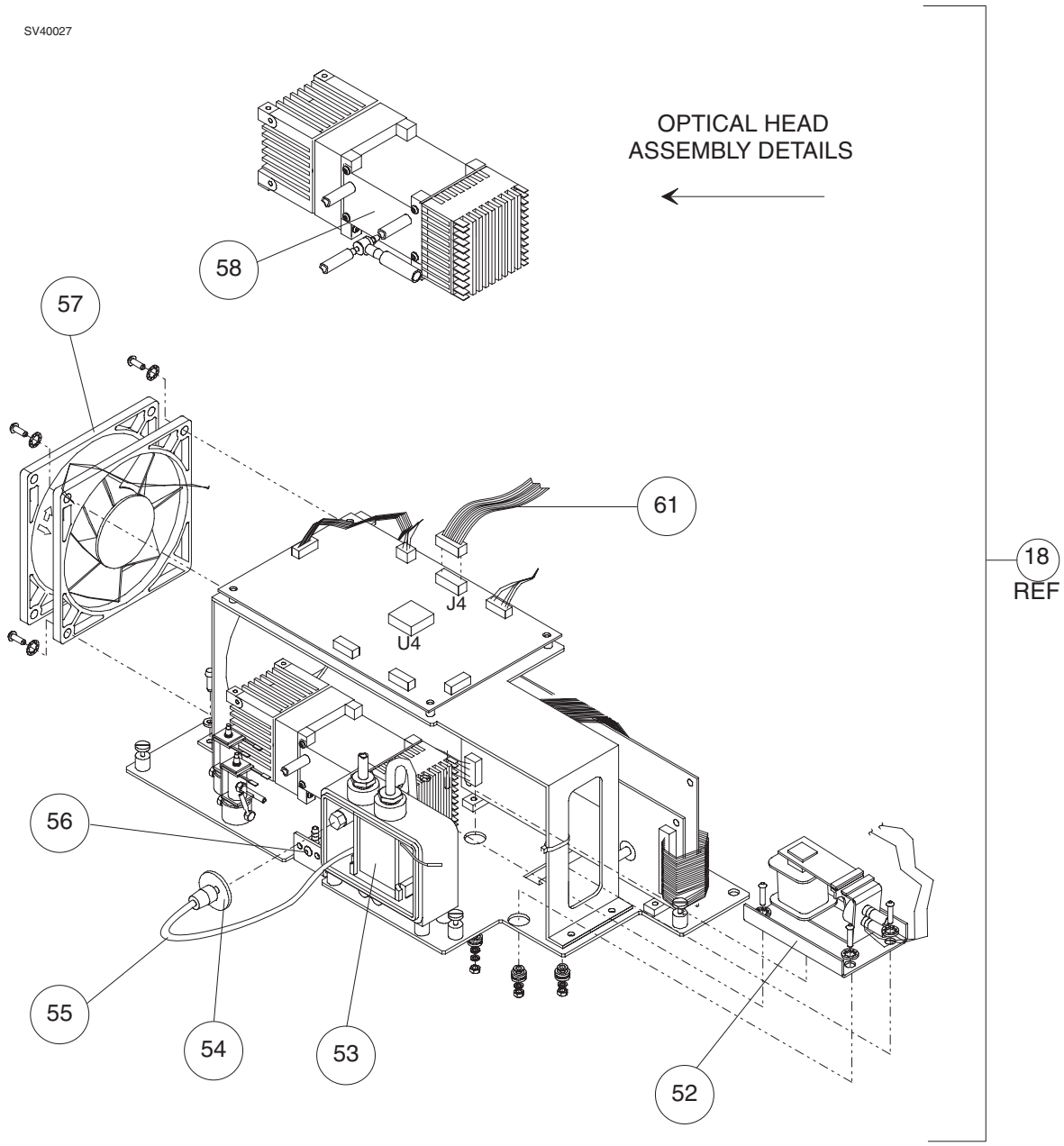
**SPARE AND REPLACEMENT PARTS (continued)** **NM4**



| ITEM | DESCRIPTION | PART NUMBER |
|---|---|---|
| 31 | Deleted | |
| 32 | Deleted | |
| 33 | Deleted | |
| 34 | Deleted | |
| 35 | Deleted | |
| | Deleted | |
| 5(Ref.) | Pulse Oximeter Assembly (early design) | 4111098 |
| | (interim design) | 4112240 |
| 5A | Pulse Oximeter Assembly (later design with speaker & amp. as part of card cage asm) | SE4113098 |
| 36 | Speaker | 4106335 |
| 37 | Deleted | |
| 38 | Power PCB Assembly (interim design) | 4112156 |
| 38A | Speaker Amp. (Later Models) | 4112475 |
| 39 | Speaker Wire Harness (Early Models) | 4111094 |
| | (Later Models (incl. power cable)) | 4112509 |
| 40 | $SpO_2$ Interface Panel and Cable Assembly | 4109118 |
| 41 | Cable, Oximeter Module to Backplane | 4111325 |
| | Cable for use with Item 5A | 4109131 |
| 41A | Cable, Oximeter Module to Backplane (Novametrix) | 4114885 |
| 41B | Oximeter Module (Novametrix) | 4114877 |


18
(REF)
SV00566

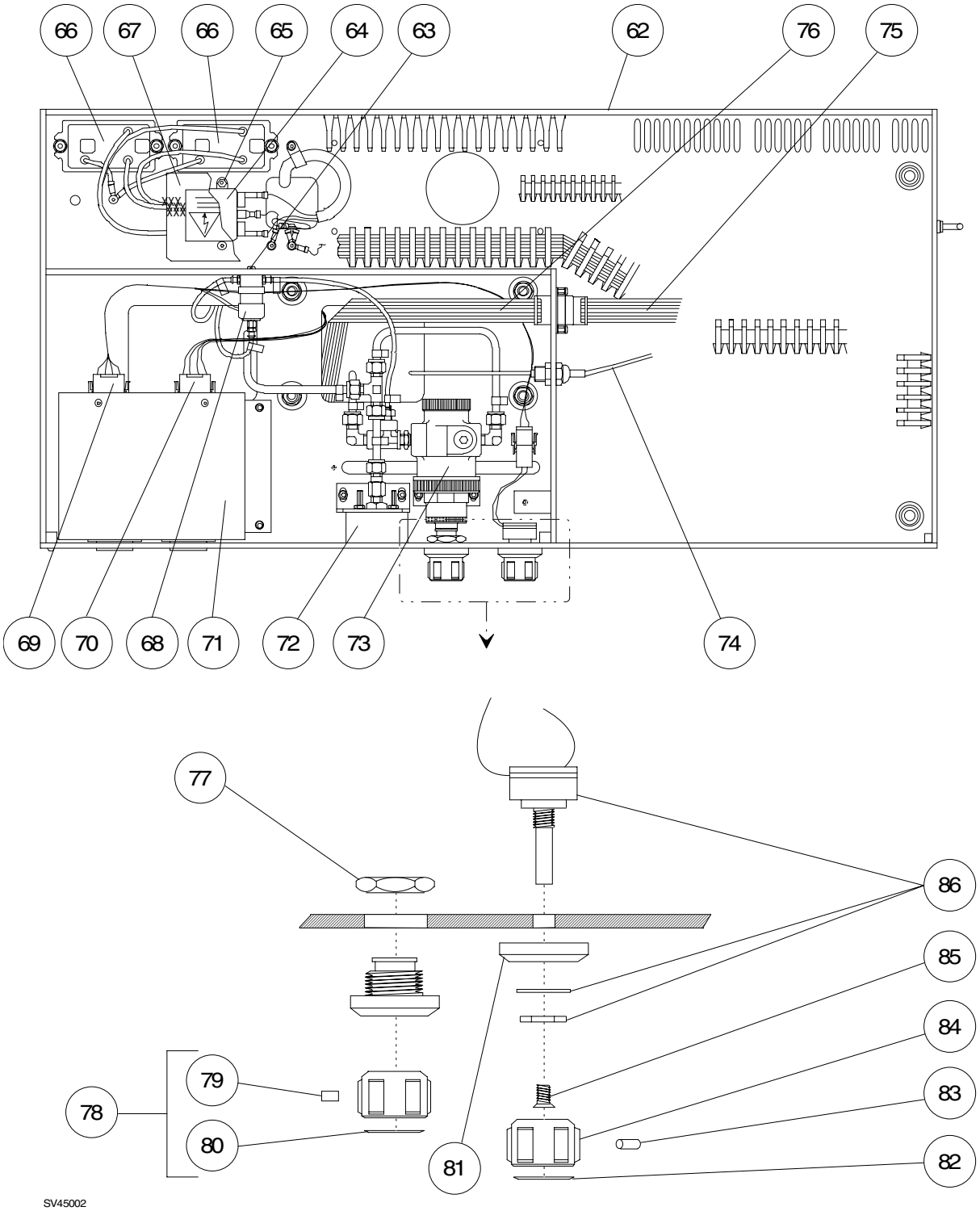
| ITEM | DESCRIPTION | PART NUMBER |
|---|---|---|
| 18 (Ref.) | Multispec Analyzer Assembly (Model 4600) | 4111411 |
| | Upgrade Kit: Multispec Analyzer Assembly (Model 4610) | S010217 |
| 42 | Deleted | |
| 43 | Deleted | |
| 44 | Deleted | |
| 45 | Deleted | |
| 46 | Deleted | |
| 47 | Deleted | |
| 48 | Deleted | |
| 49 | Deleted | |
| 50 | Deleted | |
| 51 | Deleted | |


SV40027
OPTICAL HEAD
ASSEMBLY DETAILS
58
57
61
J4
U4
18
REF
56
55
54
53
52

| ITEM | DESCRIPTION | PART NUMBER |
|---|---|---|
| 18 (Ref.) | Multispec Analyzer Assembly (Model 4610) | 4112181 |
| | Service Exchange | SE4112181 |
| 52 | Pump, Air, 12 VAC | 4110895 |
| | Screw, Pump Mounting (4x) | HW09027 |
| | Washer, Pump Mounting (4x) | HW66006 |
| | Nut, Pump Mounting (4x) | HW55003 |
| | Grommet, Pump Mounting (4x) | 4110883 |
| 53 | Disposable Reservoir (Water Trap) | 4110616 |
| 54 | Air Filter | 4111751 |
| 55 | PVC Sample Line | 4112264 |
| | Later design w/Luer fitting gender change to prevent connection to water trap housing without air filter | 4113334 |
| 56 | Restrictor, Adjustable | 4107995 |
| 57 | Fan Assembly | 4111370 |
| | Screw, Fan Mounting (4x) | HW09000 |
| 58 | Sample Cell | S010194 |
| 59 | Deleted | |
| 60 | Deleted | |
| | Input Restrictors | |
| | S18 (in line connected to top of water trap housing) | 4111758-002 |
| | *S34 (in line connected to solenoid valve | 4111758-004 |
| 61 | Cable, Multispec HC11 J4 to Backplane | 4111349 |

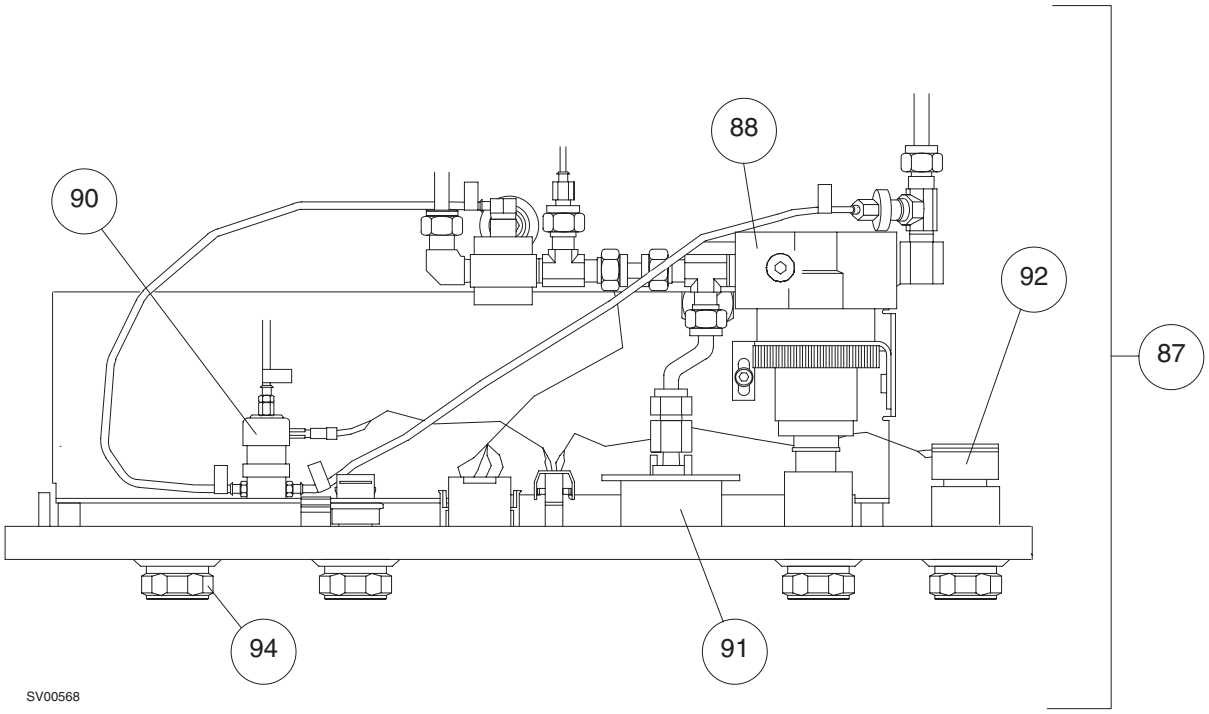
*Previously located in line connected to right top of water trap housing.

MACHINES WITH AV-E VENTILATOR



| ITEM | DESCRIPTION | PART NUMBER |
|---|---|---|
| | Machines with AV-E Ventilator: | |
| 62 | Ventilator Box Assembly | 4108918 |
| 63 | Screw, Ventilator Solenoid Mounting (2x) | HW02011 |
| 64 | AC Power Filter | 4107759 |
| 65 | Spacer, AC Power Filter Mounting (2x) | 4110589-007 |
| 66 | AC Receptacle (2x) | 4106086 |
| | AC Receptacle, later design (not interchangeable) | 4112574-001 |
| 67 | Cover, AC Power Filter | 4109622 |
| | Later replaced by | 4112822 |
| | Screw, AC Power Filter Cover (2x) | HW09016 |
| 68 | Ventilator Solenoid | 4110906 |
| 69 | Wire Harness, AVE Switch and Solenoid | 4109771 |
| 70 | Wire Harness, Alarm Channel | 4109236 |
| 71 | Ventilator Controller Assembly | 4108948 |
| | Service Exchange | SE4108948 |
| 72 | Inspiratory Flow Gauge Assembly | 4108856 |
| | New Part Number (Gauge Only) | 4111989 |
| 73 | Inspiratory Flow Regulator Assembly | 4108846 |
| | Service Exchange | SE4108846 |
| | Norgren Repair Kit (square body) | S010060 |
| | Regulator Repair Kit (round body) | 4105893 |
| 74 | Cable Assembly, Vapor Lights | 4111553 |
| 75 | Cable Assembly, Ventilator Box to Monitor Box | 4109267 |
| 76 | Cable Assembly, Ventilator Box to Alarm Channel | 4109072 |
| 77 | Nut, Knob Assembly Mounting | 4107460 |
| 78 | Knob Assembly, Incl. Knob, Bezel and Shaft Coupling | 4107556 |
| 79 | Setscrew | HW04007 |
| 80 | Label | 4103396 |
| 81 | Bezel | 4109767 |
| 82 | Label | 4107453 |
| 83 | Setscrew | HW04007 |
| 84 | Knob | 4103394 |
| 85 | Screw, Bezel Retainer (2x) | HW03038 |
| 86 | Switch Assembly | 4109768 |

MACHINES WITH AV-2 VENTILATOR



| ITEM | DESCRIPTION | PART NUMBER |
|---|---|---|

Machines with AV-2 Ventilator:

| | | |
|---|---|---|
| 87 | AV-2 Ventilator Controller Assembly (Bezel Assembly) | 4112273 |
| | Service Exchange part number is | SE4112273-S01 |
| 88 | Inspiratory Flow Regulator (no SE available) | 4102045 |
| 89 | Deleted | |
| 90 | Solenoid | 4110906 |
| 91 | Gauge | 4112251-001 |
| 92 | On-Off Switch & Wire Harness (Incl. Solenoid Wire Harness) | 4112253 |
| 93 | Deleted | |
| 94 | Knob (4x) | 4112157 |
| | (new part number) | 4113281 |
| | Knob Cover (3x) (all except ON-OFF switch) | 4112245-003 |
| | (new part number) | 4113278-002 |
| | Knob Cover (ON-OFF switch) | 4112245-002 |
| | (new part number) | 4113278-001 |

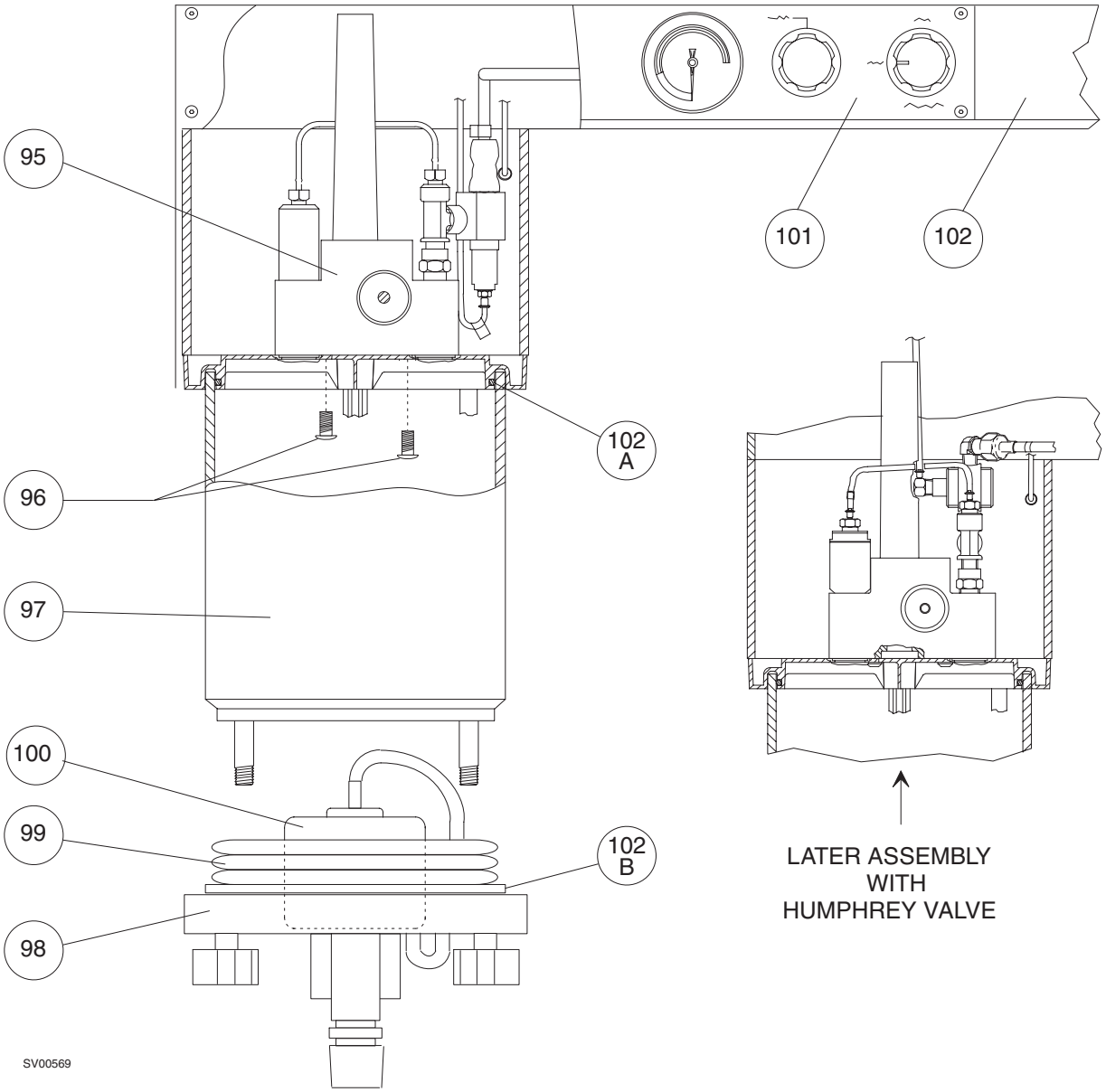
Regulator Repair Kits:

| | |
|---|---|
| AV2 | 4115151 |
| AV2+ | 4114252 |

Machines with AV-2+ Ventilator:

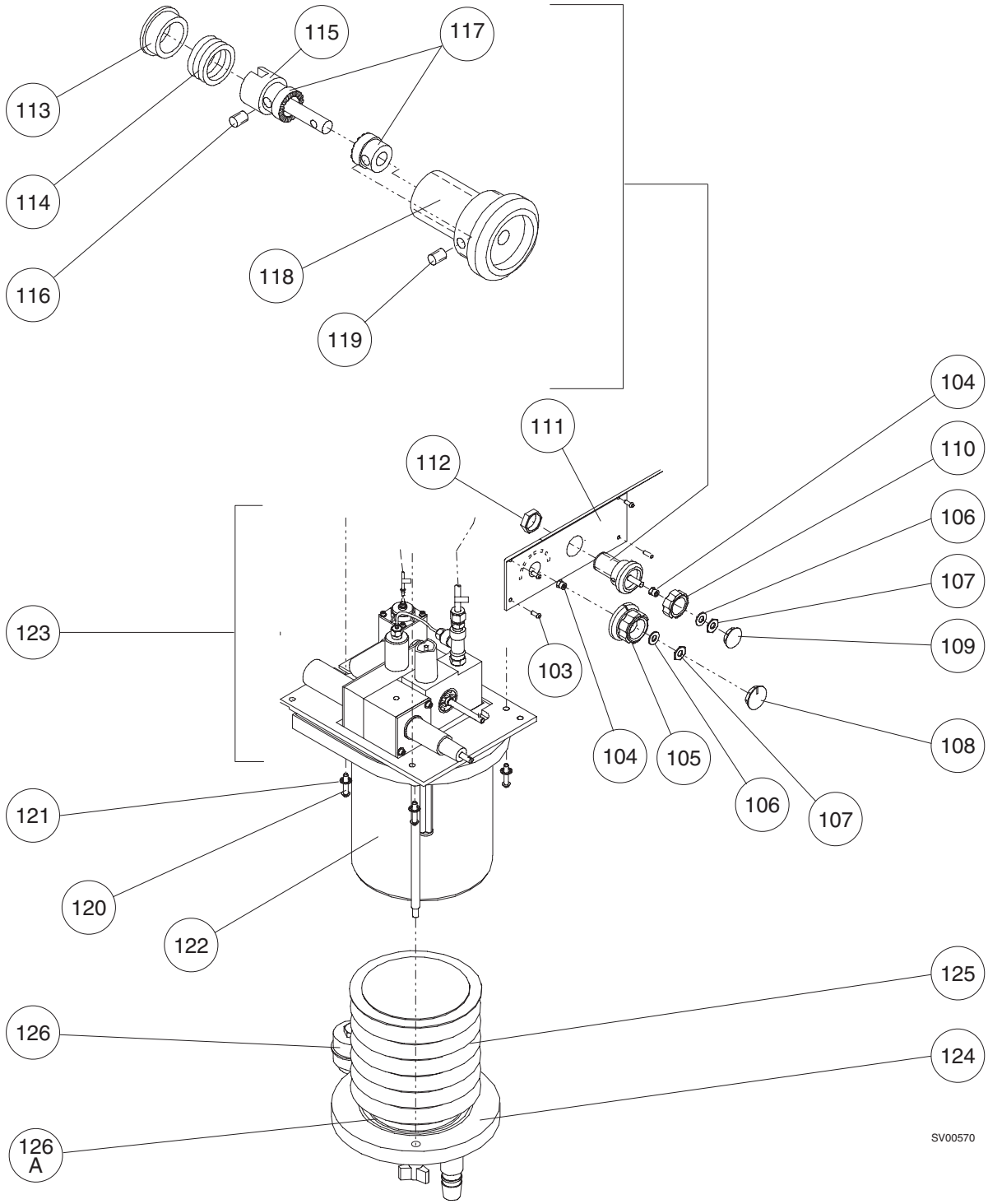
| | | |
|---|---|---|
| 87 | AV-2+ Ventilator Controller Assembly (Bezel Assembly) | 4113132-001 |
| | Service Exchange | SE4113132-001 |
| 88 | Inspiratory Flow Regulator (no SE available) | 4102045 |
| 89 | Supply Valve | 4111649 |
| 90 | Solenoid | 4110906 |
| 91 | Gauge | 4112251-001 |
| | Solenoid Wire Harness | 4113137 |
| 92 | On-off switch & wire harness | 4113136 |
| 93 | Deleted | |
| 94 | Knob (4x) | 4113281 |
| | Knob Cover (3x) (all except ON-OFF switch) | 4113278-002 |
| | Knob Cover (ON-OFF switch) | 4113278-001 |

MACHINES WITH AV-E VENTILATOR



| ITEM | DESCRIPTION | PART NUMBER |
|---|---|---|
| | Machines with AV-E Ventilator: | |
| 95 | Ventilator Bellows Valve & Guide Assembly | 4110775 |
| | Service Exchange | SE4110775 |
| 96 | Screw, Valve & Guide Assembly Mounting (2x) | HW09013 |
| 97 | Bellows Canister | 4106948 |
| 98 | Bellows Assembly, Adult | 4106935 |
| | Service Exchange | SE4106935 |
| 99 | Deleted | |
| | Kit, Bellows, adult w/pressure limit control | S4109664 |
| | Service Exchange, Bellows, adult w/pressure limit control | SE4109664 |
| | Urethane (non-latex) Bellows Sub-asm, Adult | 4106930-001 |
| | O-ring #217 (neoprene) | 4101817 |
| | Bellows asm, pediatric | 4109700 |
| 100 | Relief Valve Assembly | 4108050 |
| | Diaphragm assembly | 4110960 |
| 101 | Ventilator Box Front Panel, Left | 4111420 |
| 102 | Ventilator Box Front Panel, Right | 4111421 |
| | Ventilator Box Front Panel, Right (with O.R. Data Manager Option) | 4111475 |
| 102A | O-ring, #256, canister gasket | 4107018 |
| 102B | Gasket | 4105849 |

MACHINES WITH AV-2 VENTILATOR

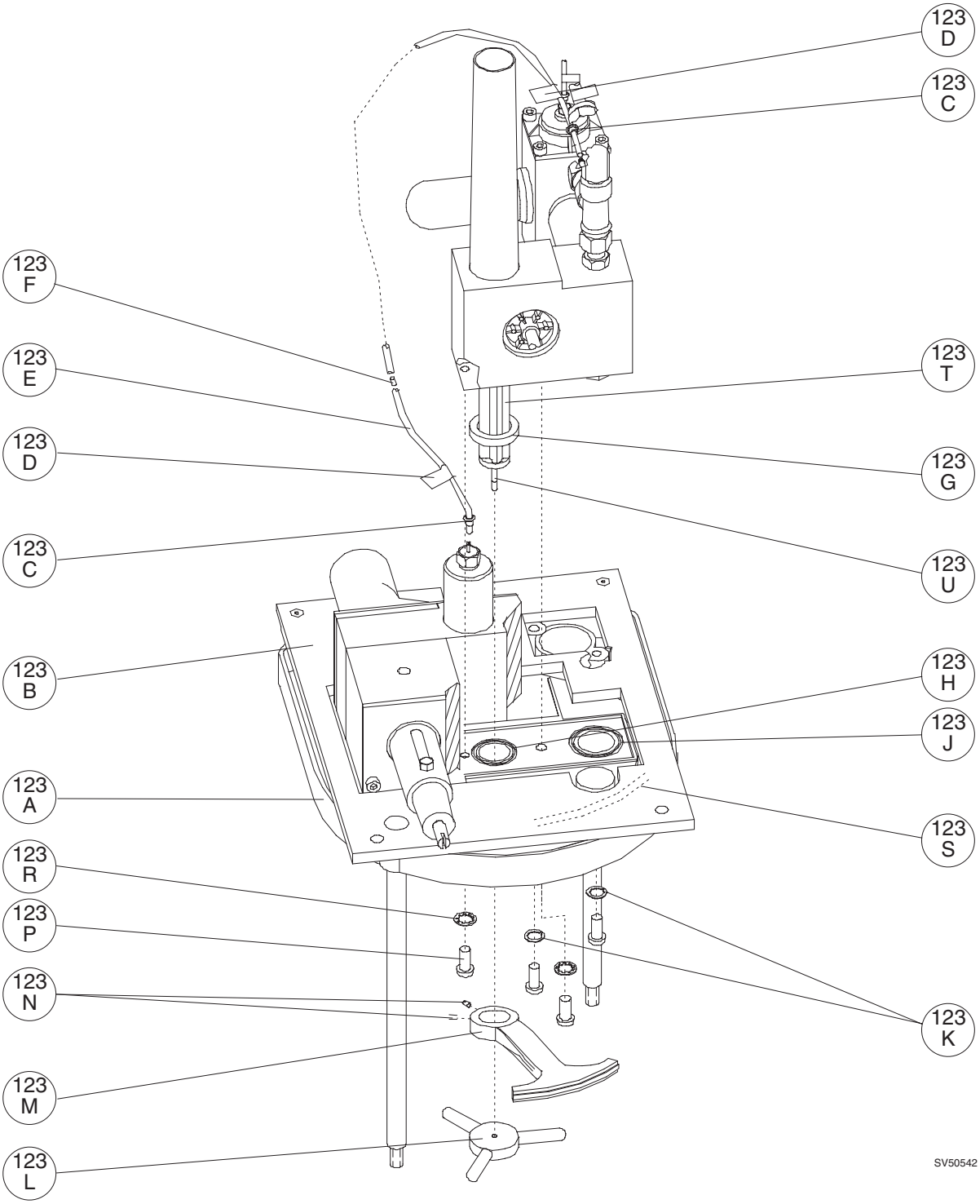


| ITEM | DESCRIPTION | PART NUMBER |
|---|---|---|

Machines with AV-2 Ventilator:

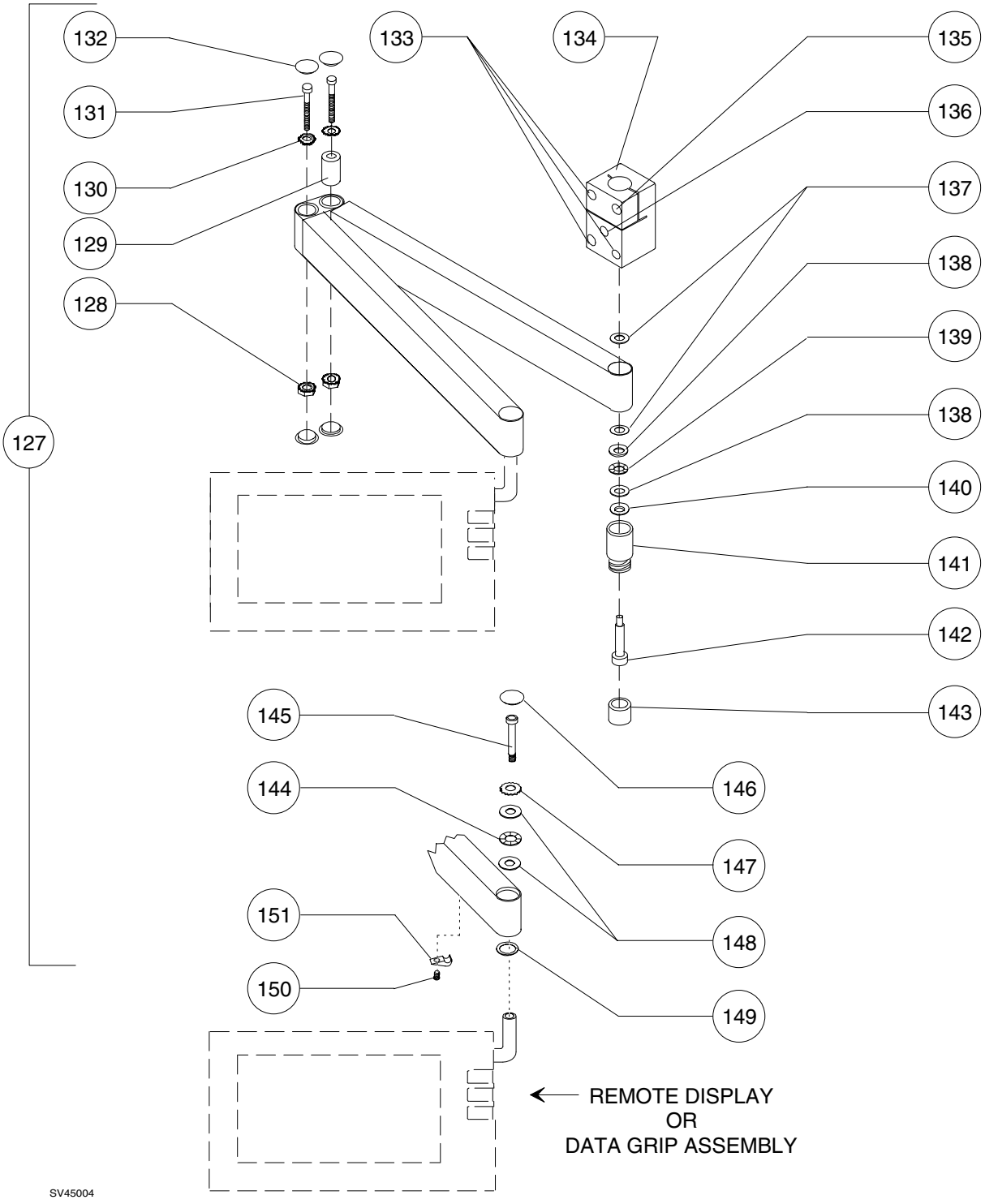
| | | |
|---|---|---|
| 103 | Screw, 6-32 x ⅜ in. Btn Hd Skt (4x) | HW09000 |
| 104 | Collet | 4112167 |
| 105 | Knob, PLC Adj. | 4112502 |
| | (new part number) | 4113279 |
| 106 | Flat Washer, #10 | HW66003 |
| 107 | Hex Nut, M5 x 0.5 | 4112066 |
| 108 | Knob Cover | 4112245-002 |
| | (new part number)(+/-) | 4113278-001 |
| 109 | Knob Cover | 4113278-002 |
| 110 | Knob | 4112152 |
| | (new part number) | 4113280 |
| 111 | Front Plate, Bellows Box | 4112230 |
| 112 | Panel Nut | 4107460 |
| 113 | Spring Retainer | 4107546 |
| 114 | Spring | 4110975 |
| 115 | Shaft | 4112175 |
| 116 | Set Screw, 6-32 x 3/16 in. | HW07002 |
| 117 | Clutch | 4107544 |
| 118 | Housing | 4112467 |
| 119 | Set Screw, 6-32 x ¼ in. | HW04003 |
| 120 | Screw, ¼-20 x 1 in. Btn Hd Skt (3x) | HW09057 |
| 121 | Lock Washer, ¼ int-t (3x) | HW67017 |
| | | |
| 122 | Canister | 4106948 |
| | Tidal Volume Indicator | 4108276 |
| | Bellows Guide | 4110735 |
| | | |
| 123 | Bellows Valve Assembly (parts breakdown listed on a subsequent page) | 4112272 |
| | Service Exchange | SE4112272-S01 |
| | | |
| 124 | Bellows Assembly, Adult | 4106935 |
| | Service Exchange | SE4106935 |
| | | |
| 125 | Urethane (non-latex) Bellows Sub-asm, Adult | 4106930-001 |
| | O-ring #217 (neoprene) | 4101817 |
| 126 | Relief Valve Assembly | 4108050 |
| | Diaphragm Assembly | 4110960 |
| 126A | Gasket | 4105849 |

## SPARE AND REPLACEMENT PARTS (continued) NM4

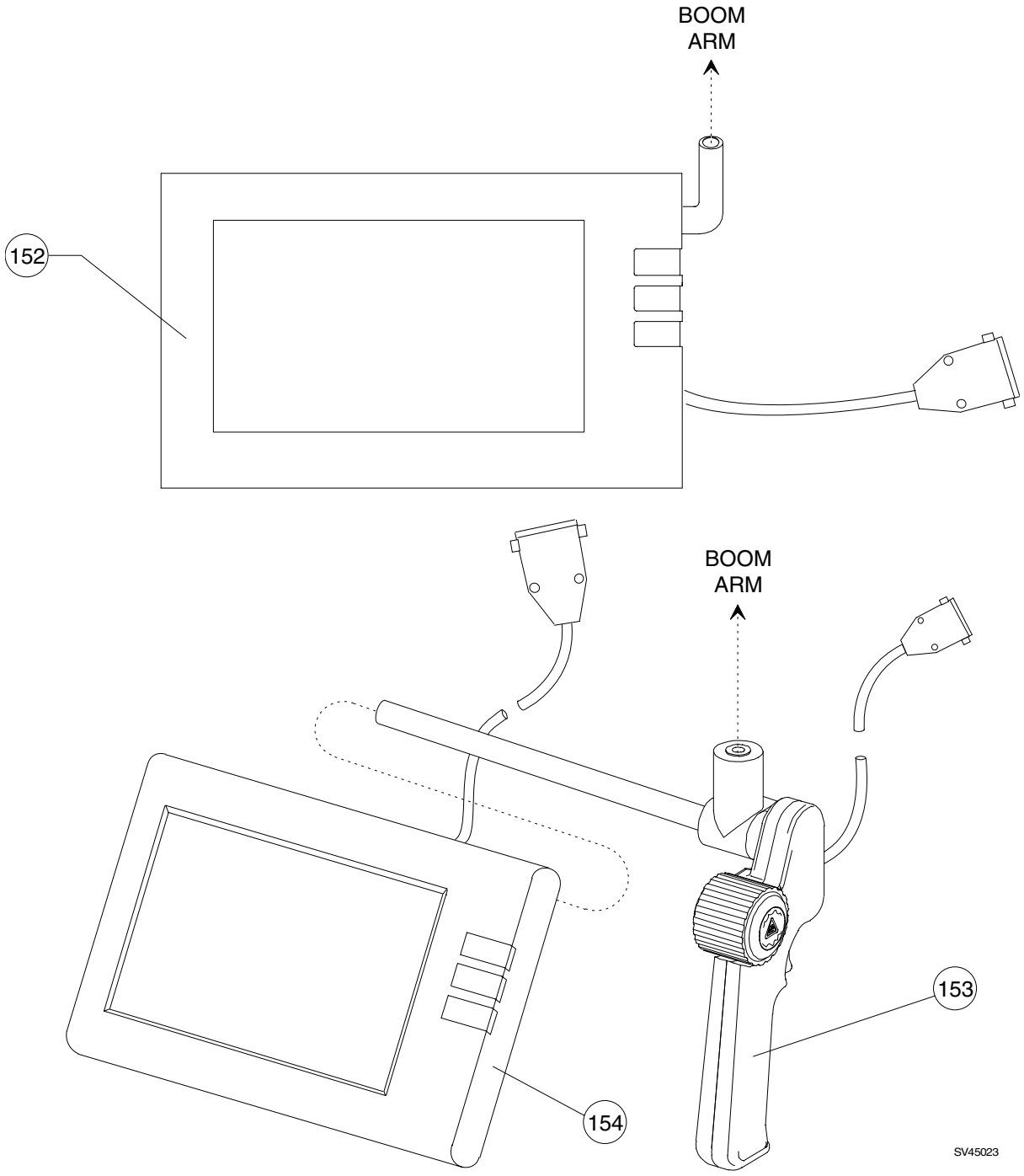


| ITEM | DESCRIPTION | PART NUMBER |
|---|---|---|
| 123(Ref) | Bellows Valve Assembly | 4112272 |
| | Service Exchange | SE4112272-S01 |
| 123A | Bellows Top Plate | 4111872 |
| 123B | Adapter Plate | 4111979 |
| 123C | Press-on Hose Clamp (2x) | 4104161 |
| 123D | Label, $O_2$ Tubing (2x) | 4109871 |
| 123E | Hose, 0.075 I.D. | ML08003 |
| 123F | Restrictor | 4107639 |
| 123G | Guide Ring | 1101294 |
| 123H | O-ring #019 (Silicone) | 4107096 |
| 123J | O-ring #022 (Neoprene) | 4104595 |
| 123K | Lockwasher, #8 Split (2x) | HW65011 |
| 123L | Bellows Top Guide | 4110735 |
| 123M | Volume Indicator | 4108276 |
| 123N | Set Screw, 6-32 x ¼ in. cup point (2x) | HW04003 |
| 123P | Screw, 8-32 x ⅜ in. btn hd skt (4x) | HW09008 |
| 123R | Lock Washer, #8 int-t (2x) | HW67000 |
| 123S | O-ring #256 (Neoprene) | 4107018 |
| 123T | Rod, Bellows Adjustment | 4110727 |
| 123U | Rod | 4106918 |

## SPARE AND REPLACEMENT PARTS (continued) NM4

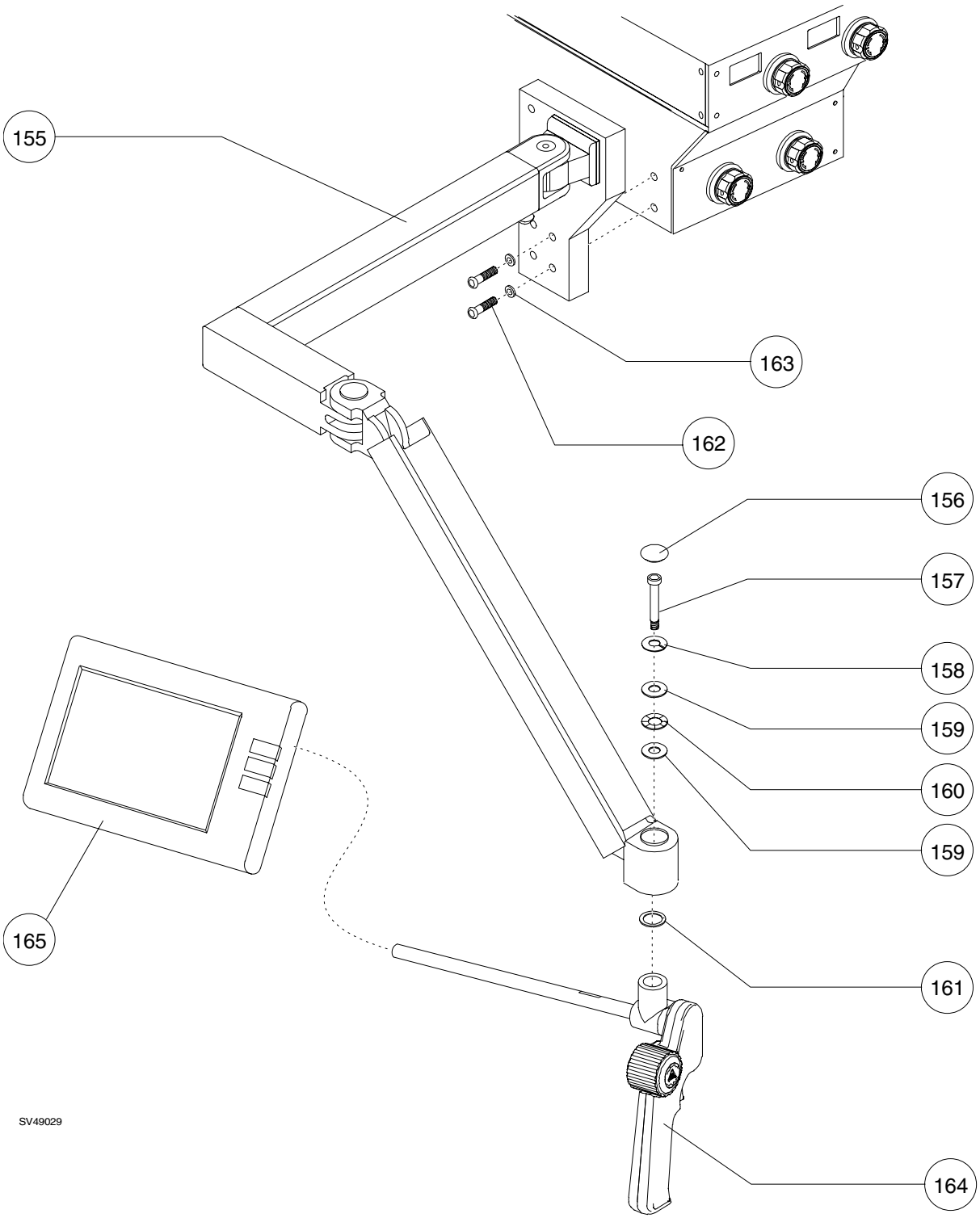


| ITEM | DESCRIPTION | PART NUMBER |
|---|---|---|
| 127 | Boom Arm (Complete Assembly) | 4111212 |
| 128 | Nut with Captive Lockwasher (2x) | HW55004 |
| 129 | Spacer (Bushing) | 4110792-053 |
| | Spacer (Washer) (2x) | 4110792-052 |
| 130 | Lockwasher (2x) | HW68004 |
| 131 | Screw, Center Hinge (2x) | HW01040 |
| 132 | Cap, Center Hinge, Upper & Lower (4x) | 4111183 |
| 133 | Screw, Boom Arm Mounting (3x) | HW01082 |
| 134 | Boom Arm Mounting Block | 4111198 |
| 135 | Screw, Upper Boom Arm Clamp | HW01041 |
| 136 | Setscrew, Boom Arm Hinge | HW15002 |
| 137 | Washer, Delrin (2x) | 4110792-043 |
| 138 | Washer, Thrust (2x) | 4110792-040 |
| 139 | Bearing, Boom Arm Hinge | 4111182 |
| 140 | Washer, Spring | 4111180 |
| 141 | Gauge Mount | 4111190 |
| 142 | Screw, Boom Arm Hinge | 4111199-002 |
| 143 | Cap, Gauge Mount | 4111252 |
| 144 | Bearing | 4111181 |
| 145 | Screw, Remote Display or Datagrip Mounting | 4111199-001 |
| 146 | Cap | 4111184 |
| 147 | Lockwasher | HW68004 |
| 148 | Washer, Thrust (2x) | 4110792-045 |
| 149 | Washer, Delrin | 4110792-044 |
| 150 | Screw, Cable Clamp Retaining (4x) | HW09000 |
| 151 | Cable Clamp (with Remote Display only) (4x) | 4111217 |
| | Cable Clamp (with Datagrip and Remote Display) (4x) | 4112300 |


BOOM
ARM
152
BOOM
ARM
153
154
SV45023

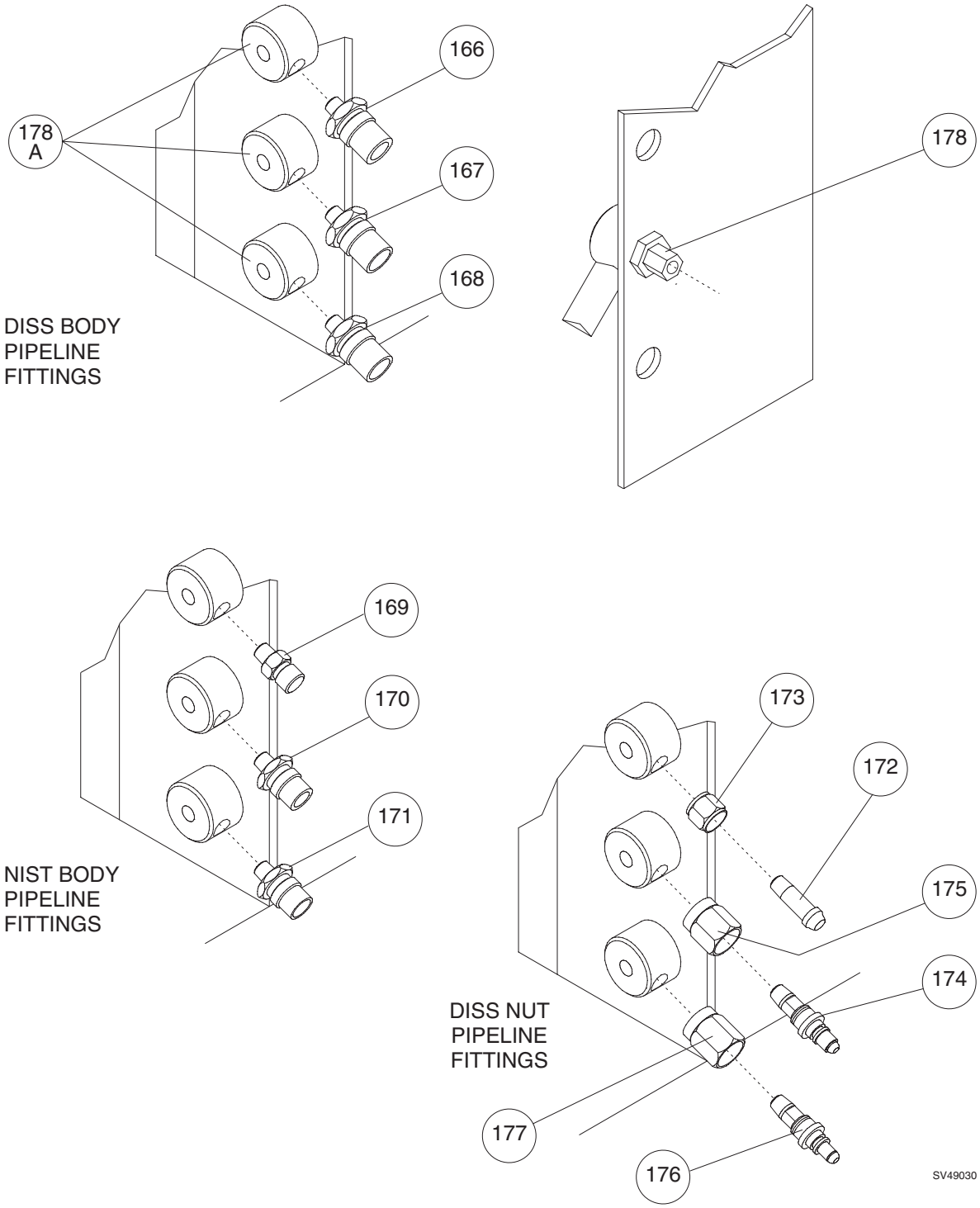
| ITEM | DESCRIPTION | PART NUMBER |
|---|---|---|
| 152 | Remote Display (W/O Datagrip) Assembly (Incl. Cable) | 4111210 |
| | Service Exchange | SE4111210 |
| | Cable assembly, data/power (used on 4111210 and 4112314) | 4111207 |
| | Strain relief | 4111187 |
| 153 | Datagrip Assembly (Incl. Cable) | 4111907 |
| | Service Exchange | SE4111907 |
| | Knob, Datagrip | 4111782 |
| | Label, Dot, Datagrip | 4111882 |
| | O-ring #021 (Neoprene) | 4104576 |
| | Set screw, 6-32 x 1/2 in. cup pt | HW04032 |
| | Spring, CPRSN | 4110975-020 |
| | Trigger, Datagrip | 4111780 |
| | Strain relief | 4113088-001 |
| | Cable assembly | 4112779-001 |
| 154 | Remote Display Assembly (Incl. Cable) | 4112314 |
| | Service Exchange | SE4112314 |

## SPARE AND REPLACEMENT PARTS (continued) NM4



| ITEM | DESCRIPTION | PART NUMBER |
|---|---|---|
| 155 | Display Arm Assembly | 4112524 |
| | Later Replaced by | 4112591-001 |
| 156 | Cap, Plastic | 4111184 |
| 157 | Mounting Screw | 4111199-004 |
| 158 | Lockwasher | HW65010 |
| 159 | Spacer (2x) | 4110792-045 |
| 160 | Bearing | 4111181 |
| 161 | Spacer, Delrin | 4110792-044 |
| | Cable Clamp, ⅜ in. (3x) | 4112300 |
| | Screw, Cable Clamp, 6-32 x ⅜ (3x) | HW09000 |
| 162 | Screw, ¼-20 x ⅞ in. Btn Hd Skt (6x) | HW09063 |
| | [If the machine is equipped with an optional manual sphygmomanometer, the lower front corner mounting screw is a ¼-20 x 2 in. P/N HW09064] | |
| 163 | Lock Washer, ¼ split (6x) | HW65010 |
| 164 | Datagrip Assembly (Incl. Cable) | 4111907 |
| | Service Exchange | SE4111907 |
| 165 | Display Assembly (Incl. Cable) | 4112314 |
| | Service Exchange | SE4112314 |

MACHINES CONFIGURED WITH AN ORC



| ITEM | DESCRIPTION | PART NUMBER |
|---|---|---|
| | DISS Body Pipeline Fittings: | |
| 166 | $O_2$ DISS Fitting* | 4102563 |
| 167 | Air DISS Fitting* | 4102886 |
| 168 | $N_2O$ DISS Fitting* | 4111384 |
| | NIST Body Pipeline Fittings: | |
| 169 | $O_2$ Male NIST Connector | 4110388 |
| 170 | Air Male NIST Connector | 4110386 |
| 171 | $N_2O$ Male NIST Connector | 4111382 |
| | DISS Nut Pipeline Fittings: | |
| 172 | $O_2$ DISS Nipple* | 4103877 |
| 173 | $O_2$ DISS Nut* | 4102848 |
| 174 | Air DISS Nipple* | 4111385 |
| 175 | Air DISS Nut* | 4103120 |
| 176 | $N_2O$ DISS Nipple* | 4111383 |
| 177 | $N_2O$ DISS Nut* | 4102850 |
| 178 | Pipeline Inlet Filter Asm (Typ., All Inlets) | 4106198 |
| | Filter | 4102532 |
| | Connector | 4106897 |
| | O-ring for $N_2O$ DISS Nipple | 4113494 |

* These items were included as part of pipeline inlet assemblies on earlier machine configurations with an ORMC. Assembly numbers are listed below for reference:

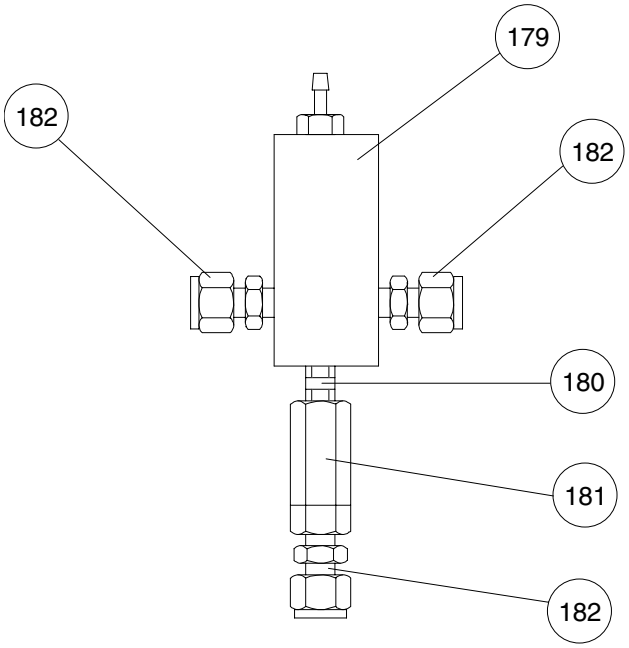
| | |
|---|---|
| Pipeline Inlet Assembly, $O_2$ | 4109345 |
| Pipeline Inlet Assembly, $O_2$ (Canada) | 4109297 |
| Pipeline Inlet Assembly, $N_2O$ | 4109344 |
| Pipeline Inlet Assembly, $N_2O$ (Canada) | 4109298 |
| Pipeline Inlet Assembly, Air | 4109412 |
| Pipeline Inlet Assembly, Air (Canada) | 4109861 |

NOTE: Positions of $O_2$ and Air pipeline inlets are reversed on earlier machines.

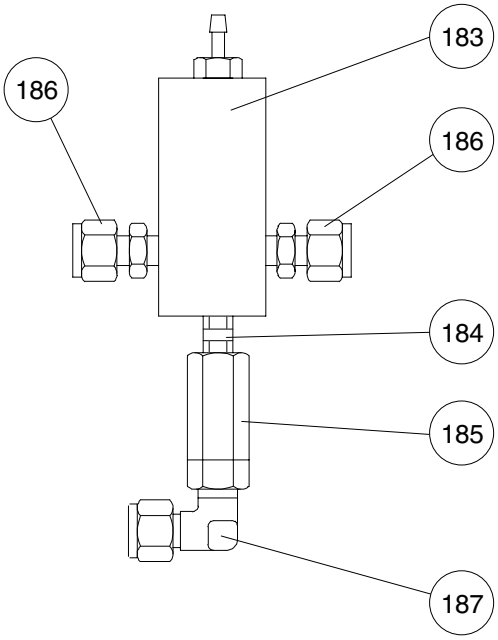
| | | | |
|---|---|---|---|
| 178A | Common Parts: Pipeline Inlet Housing | (old No.) | 4102559 |
| | | (replaced by) | 4113363 |
| | | (new no.) | 4113974 |
| | Nut, 5/8-18 | | HW52002 |
| | Lock Washer, 5/8 int-t | | HW67001 |

MACHINES CONFIGURED WITH AN ORC

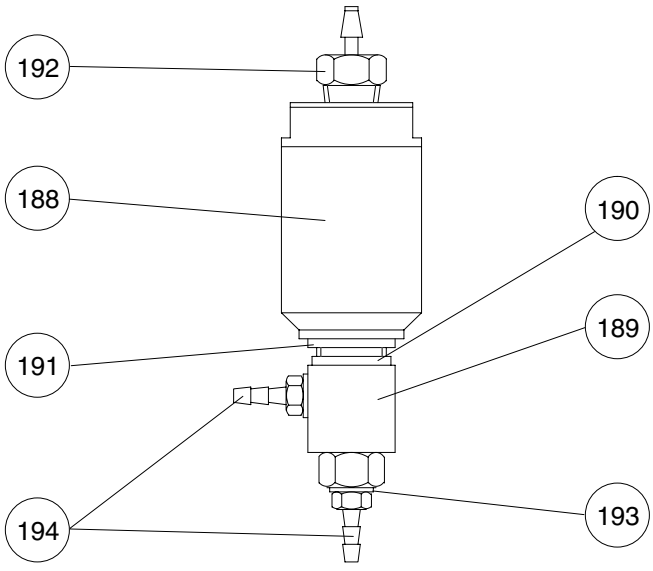
N2O FAILSAFE ASSEMBLY




AIR OR THIRD GAS FAILSAFE ASSEMBLY




MINIMUM FLOW O2 VALVE ASSEMBLY



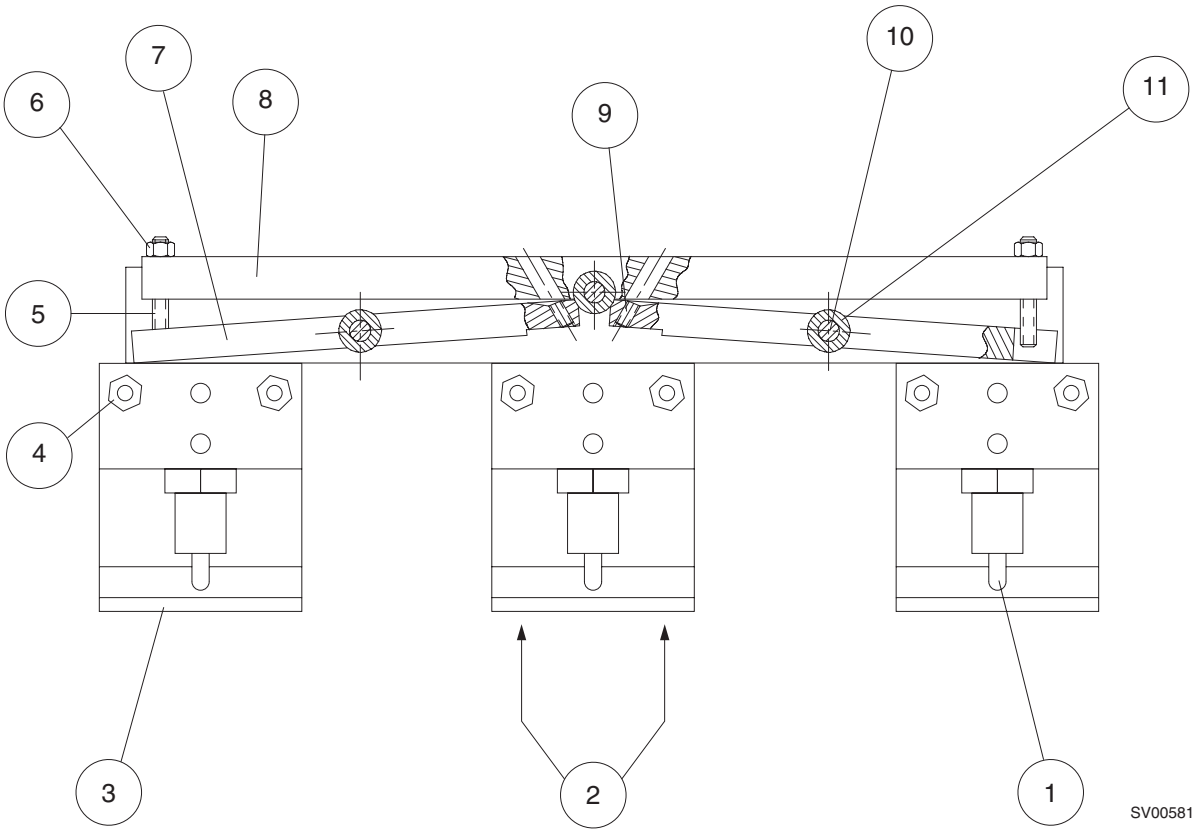

SV49031

| ITEM | DESCRIPTION | PART NUMBER |
|---|---|---|
| | *$N_2O$ Failsafe Assembly: | |
| 179 | Failsafe Block Asembly | 4112043 |
| 180 | Nipple, ⅛ NPT x ¾ in. | 4102784 |
| 181 | Check Valve, MJCV-1 | 4105815 |
| 182 | Straight Fitting, ¼Tube x ⅛ MPT (3x) | 4109408 |
| | *Air or 3rd Gas Failsafe Assembly: | |
| 183 | Failsafe Block Asembly | 4112043 |
| 184 | Nipple, ⅛ NPT x ¾ in. | 4102784 |
| 185 | Check Valve, MJCV-1 | 4105815 |
| 186 | Straight Fitting, ¼Tube x ⅛ MPT (2x) | 4109408 |
| 187 | Elbow Fitting, ¼Tube x ⅛ MPT | 4109410 |
| | Minimum $O_2$ Flow Valve Assembly: | |
| 188 | Pilot Actuator | 4102055 |
| 189 | Valve, 2-Way Poppet | 4103549 |
| 190 | Lock Washer | (Supplied with Valve) |
| 191 | Spacer | 4110792-013 |
| 192 | Fitting, nylon 1/16 I.D. Hose x ⅛ MPT | 4106366 |
| | Replaced by brass fitting (requires press-on hose clamp 4104161 instead of tie strap) | 4111771 |
| 193 | Washer (2x) | 4102165 |
| 194 | Fitting, 1/16 I.D. Hose x 10-32 (2x) | 4103445 |
| | Later design fitting has integral seal (replaces previous two items) | 4112707 |
| | Tie Strap, 0.131W x 8.04L (2x) | 1101732 |

* On earlier machine configurations with an ORMC, the failsafe assemblies are three-port devices and were listed as complete assemblies with fittings installed. Assembly numbers are listed below for reference:

| | |
|---|---|
| $N_2O$ Failsafe Assembly | 4108686 |
| Air or 3rd gas Failsafe Assembly | 4108687 |

**SPARE AND REPLACEMENT PARTS (continued)** **NM4**

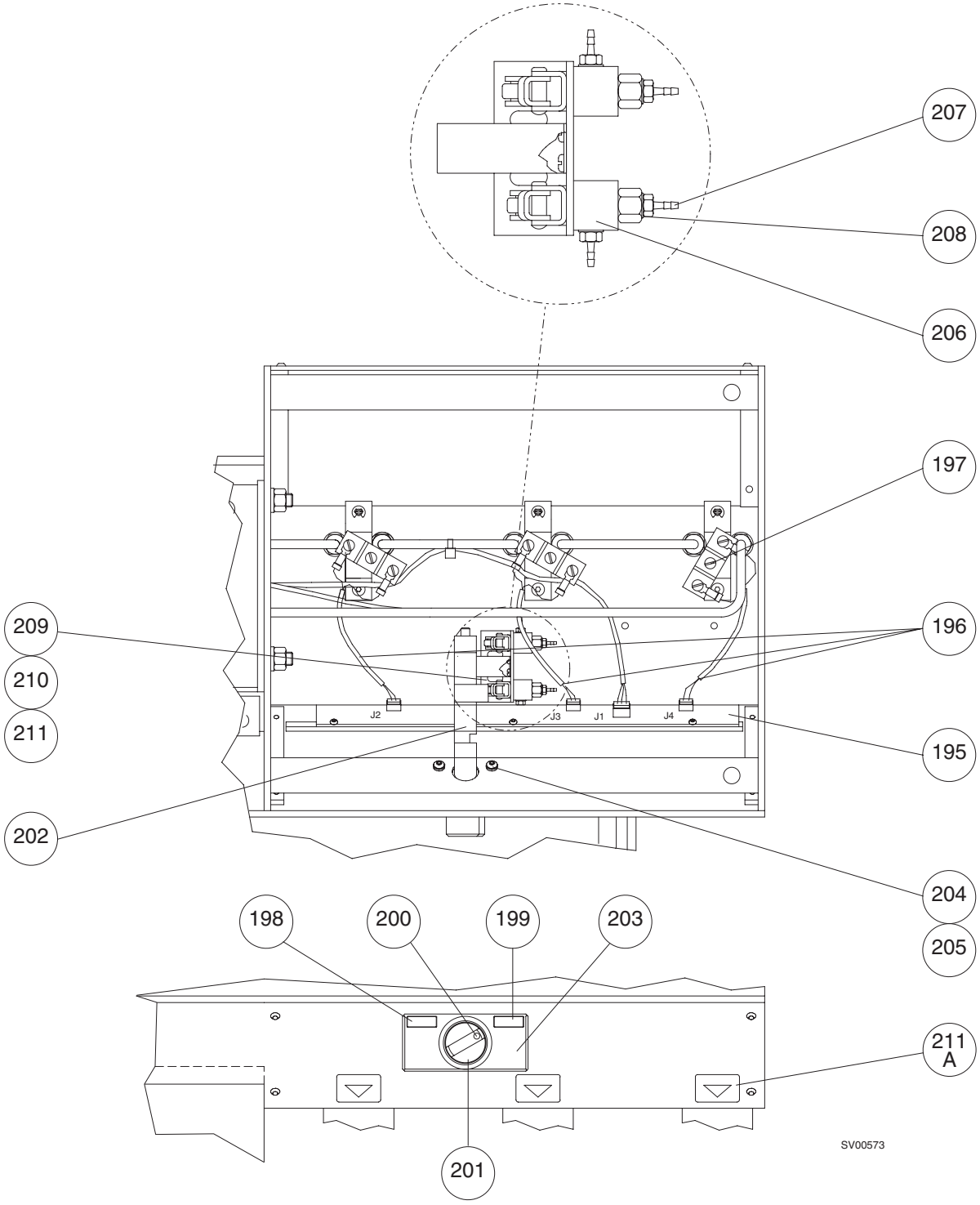


| ITEM | DESCRIPTION | PART NUMBER |
|---|---|---|
| 1 | Pin assembly | 4110187 |
| 2 | O-rings (2x per vaporizer) | 2121929 |
| 3 | Cover assembly, vapor block (plastic) | 4112699 |
| 4 | Straight fitting, 1/4 tube | 4109408 |
| 5 | Set screw, 10-32 (2x) | HW04012 |
| 6 | Kep nut, 10-32 (2x) | HW55002 |
| 7 | Pivot arm, short (2x) | 4104975 |
| 8 | Pivot arm, long | 4108043 |
| 9 | Set screw, 8-32 (2x) | 4111693 |
| 10 | Pin | 4104343 |
| 11 | Spacer | 4110792-014 |

Not shown:

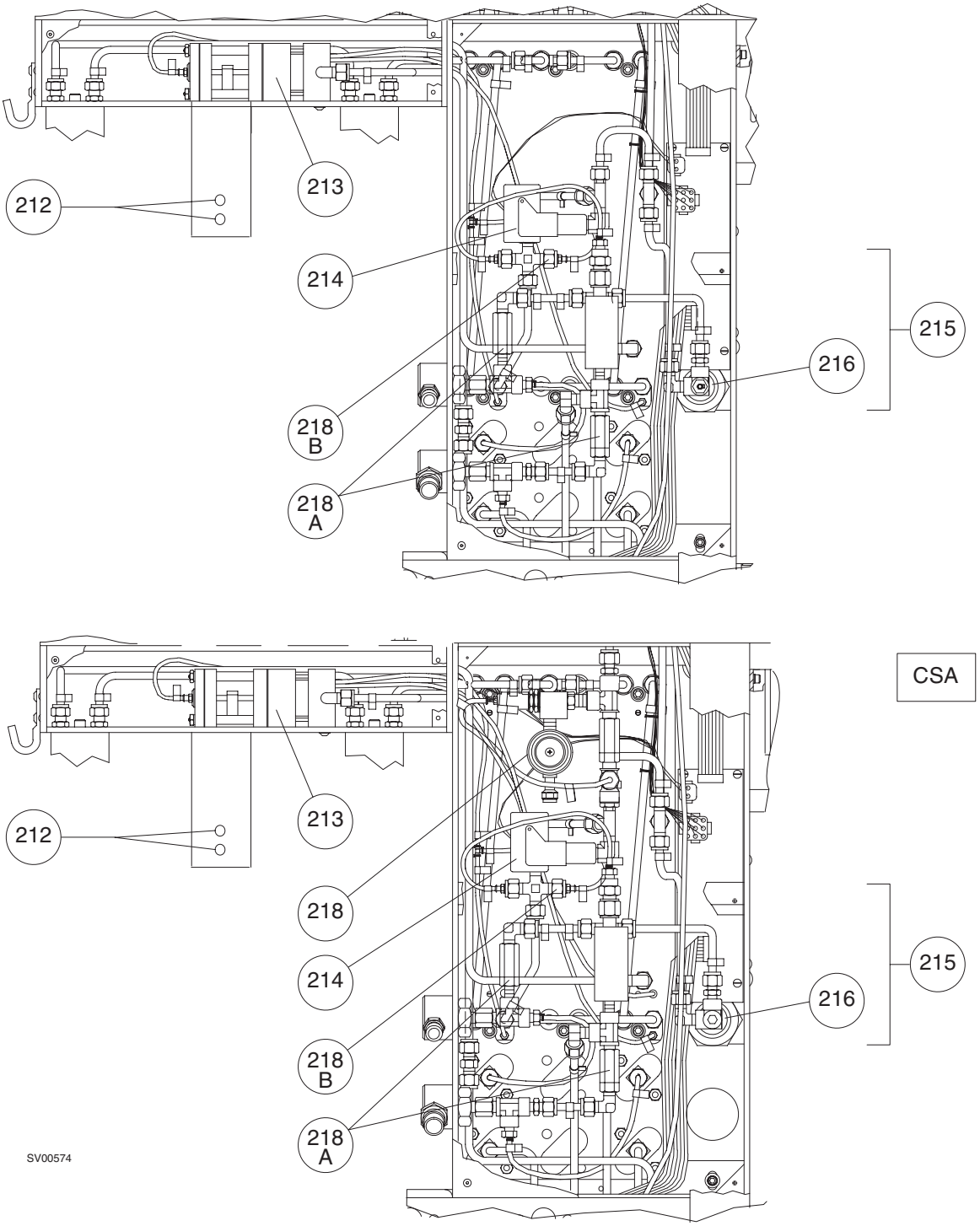
| | | |
|---|---|---|
| | Support bar | 4104976 |

MACHINES CONFIGURED WITH AN ORC



| ITEM | DESCRIPTION | PART NUMBER |
|---|---|---|
| 195 | Vapor Indicator PCB | 4110219 |
| 196 | Wire Harness, Vapor Select Switch (3x) | 4110233 |
| 197 | Switch, Vapor Select (Early Models) (3x) | 4103341 |
| | (Later Models with longer actuator (used with shorter actuator rods)) | 4111718 |
| | Gas Selector Switch Assembly: | |
| 198 | Label, $O_2$ + $N_2O$ | 4108461 |
| 199 | Label, ALL GASES | 4108462 |
| 200 | Label, Dot | 4103423 |
| 201 | Knob | 4103169 |
| | Set screw, locking, 8-32 x 3/8 in. cup pt. | HW10004 |
| | (Later style knobs use non-locking set screw) | HW04025 |
| 202 | Camshaft, Gas Selector | 4109867 |
| 203 | Block, Gas Selector Switch | 4109866 |
| 204 | Switch Asm Mounting Screws, 8-32 x 3/8 in. skt hd (2x) | HW01012 |
| 205 | Lock Washer, #8 int-t (2x) | HW67000 |
| | Valve Assembly, Gas Selector: | |
| 206 | Valve, Gas Selector (2x) | 4103621 |
| 207 | Fitting, 1/16 I.D. Hose x 10-32 (4x) | 4103445 |
| 208 | Washer (4x) | 4102165 |
| | Later design fitting has integral seal (replaces previous two items) | 4112707 |
| 209 | Valve Asm Mounting Screws, 10-32 x 5/16 in. skt hd (2x) | HW01022 |
| 210 | Lock Washer, #10 int-t (2x) | HW67006 |
| 211 | Flat Washer, #10 (2x) | HW66003 |
| 211A | Label, arrow, vaporizer | 4112055 |

EARLIER MACHINE CONFIGURATION (TYPICAL)



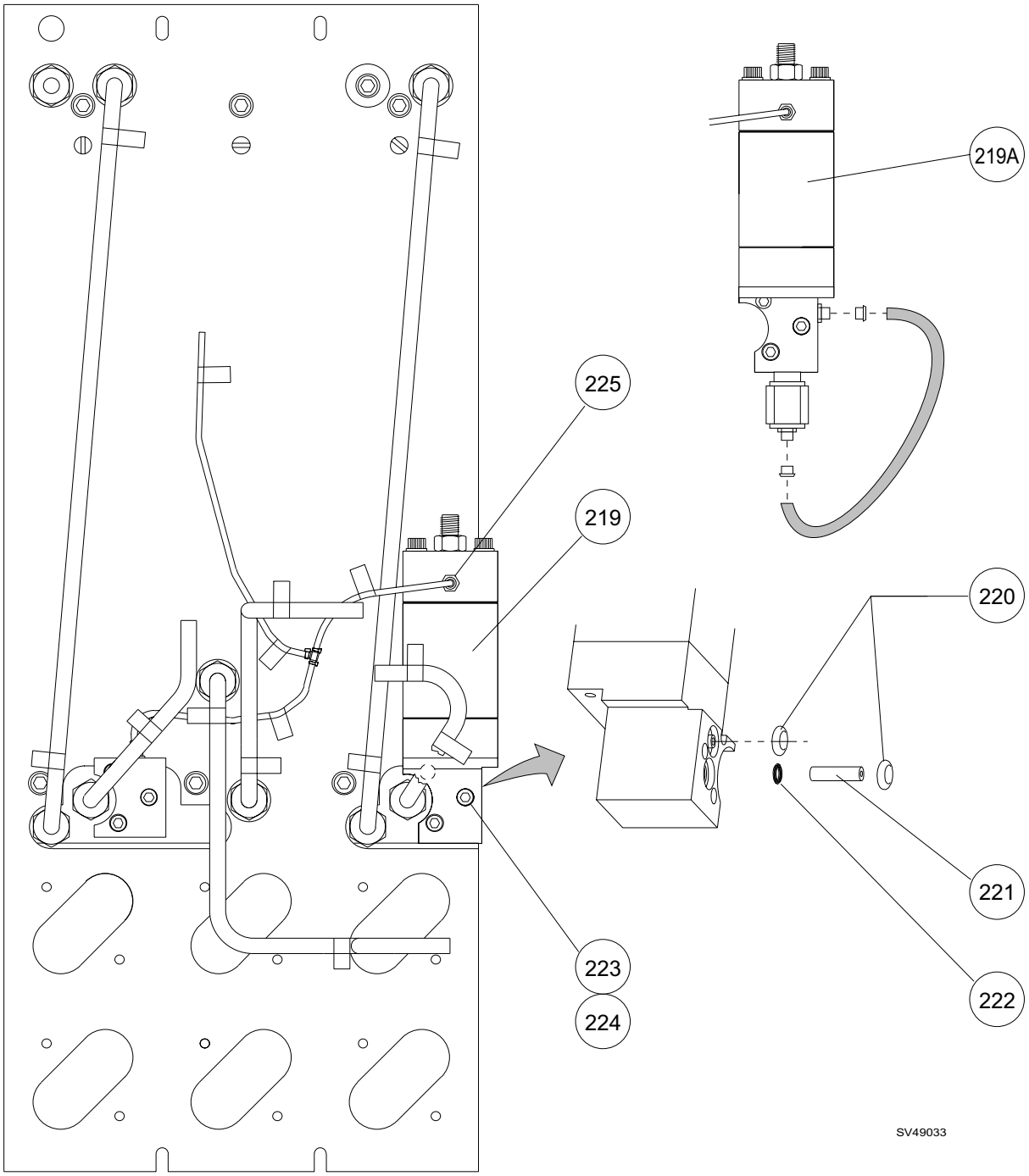
| ITEM | DESCRIPTION | PART NUMBER |
|---|---|---|
| 212 | Vaporizer Mounting Screw, 4 x 30 Metric (2x Per Vaporizer) | HW01072 |
| | Vaporizer Gasket, O-Ring (2x Per Vaporizer) | 2121929 |

The following items apply to earlier machine configurations and are listed here for reference:

| | | |
|---|---|---|
| 213 | Oxygen Ratio Monitor/Controller (ORMC) (Early models) | 4109271 |
| | (Later models without electrical connections) | 4111765 |
| 214 | Oxygen Supply Pressure Alarm Switch | 4106037 |
| 215 | Alarm Channel Assembly (Early models) | 4108592 |
| | Service Exchange | SE4108592 |
| | Later models without $O_2/N_2O$ ratio lamp | 4111522 |
| | Service Exchange | SE10029 |
| 216 | Main Switch Valve & Fitting Assembly (Early models) | 4109285 |
| 217 | Deleted | |
| 218 | Oxygen Supply Low Pressure Alarm Whistle (Canada) | 4109946 |
| | Reservoir Assembly, Alarm Whistle (Canada) | 4109947 |
| 218A | Check valve (pipeline) | 4105815 |
| 218B | Restrictor, minimum flow: | |
| | (wht) 150 mL/min. (used on units with ORMC/ORC with 25% ratio | 4110738-004 |
| | (brn) 175 mL/min. (used on units with ORC with bypass) | 4110738-007 |

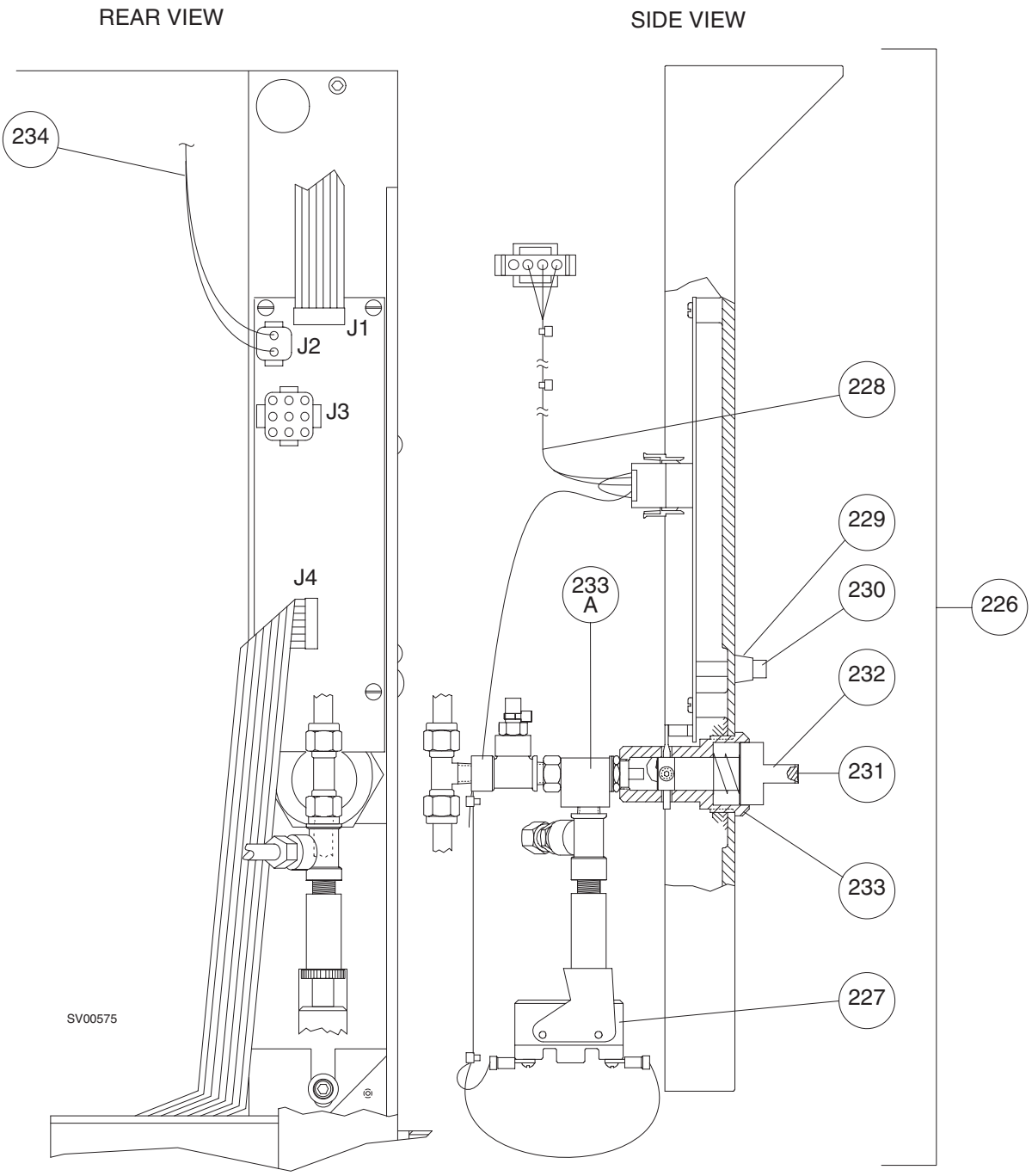
LATER MACHINES WITH ORC AS PART OF FLOWMETER SUB-ASSEMBLY

REAR VIEW OF FLOWMETER HOUSING
WITH REAR COVER REMOVED



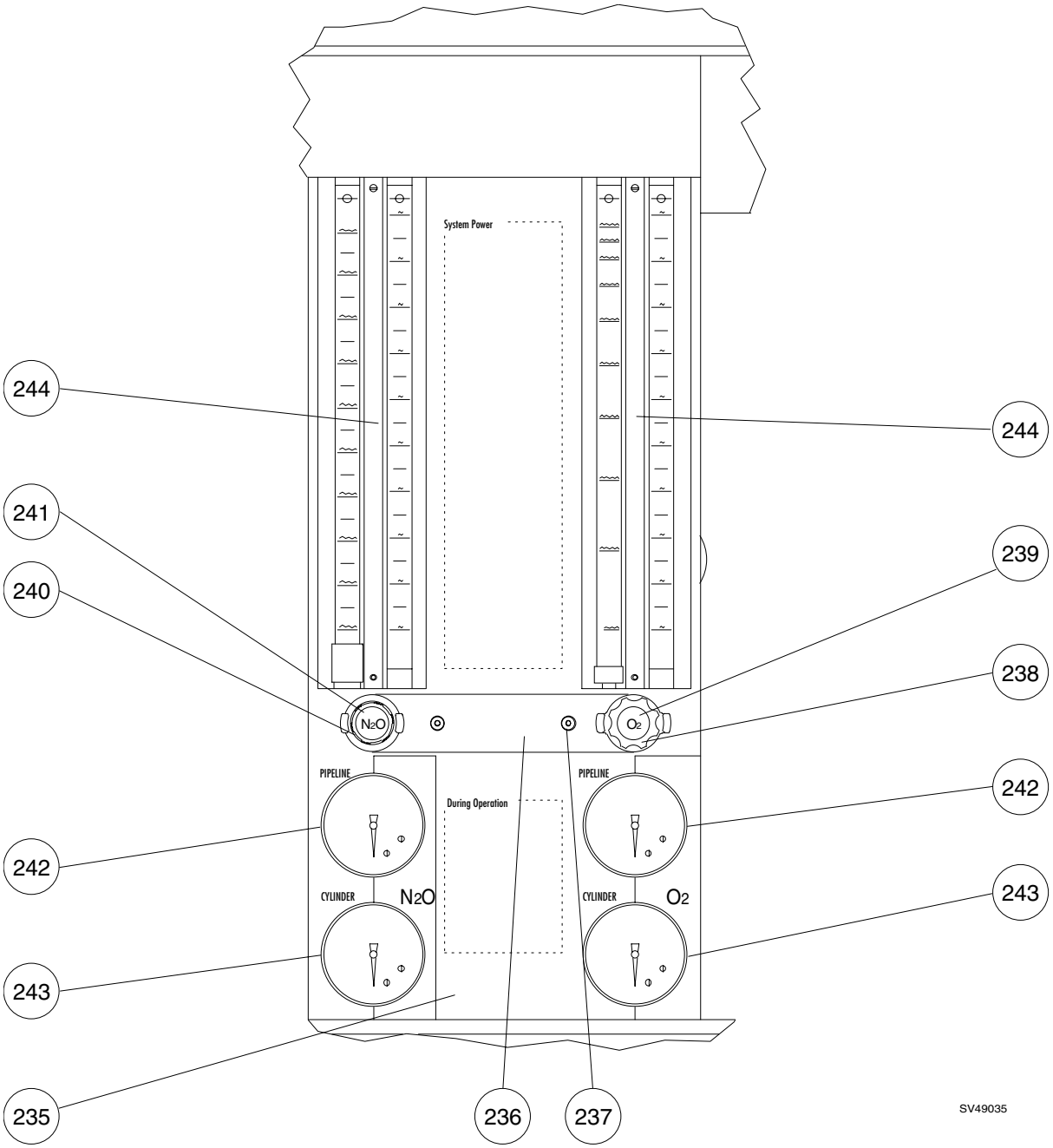
| ITEM | DESCRIPTION | PART NUMBER |
|---|---|---|
| 219 | ORC Assembly | 4111800 |
| | Service Exchange | SE4111800 |
| 219A | ORC Assembly, low flow design for later machines | 4113329-001 |
| | Service Exchange | SE4113329-001 |
| 220 | O-ring, #105 (Neoprene) (2x) | 4111893 |
| 221 | Filter | 4111805 |
| 222 | O-ring, 0.066 x 0.042 (Buna-n) | 4111894 |
| 223 | Screw, 8-32 x 1½ in. skt hd (3x) | HW01020 |
| 224 | Lock Washer, #8 split (3x) | HW65001 |
| 225 | Hose Clamp, Press-on | 4104161 |

LATER MODELS WITH OXYGEN SUPPLY PRESSURE ALARM SWITCH



| ITEM | DESCRIPTION | PART NUMBER |
|---|---|---|
| 226 | Alarm Channel Assembly | 4112125 |
| 227 | Oxygen Supply Pressure Alarm Switch | 4106037 |
| 228 | Wire Harness, Alarm Switch & J3 to Ventilator Controller | 4112146 |
| 229 | Housing, Push Button | 4106046 |
| 230 | Cap, Push Button | 4106047 |
| 231 | Label, Dot | 4103423 |
| 232 | Knob, Main Switch | 4106044 |
| 233 | Housing, Main Switch | 4106045 |
| 233A | Clippard valve | 4103588 |
| | Alarm Channel Service Replacement No. | SE10029 |
| | Alarm channel Service Exchange (old style w/O2/N2O ratio lamp) | SE4108592 |
| 234 | Wire Harness, Flowmeter Lights to Alarm Channel J2 | 4108594 |

For earlier machine configurations, see Alarm Channel listing on a previous page.


System Power
During Operation
PIPELINE
PIPELINE
CYLINDER
CYLINDER
N2O
O2
244
241
240
242
243
235
236
237
239
238
SV49035

| ITEM | DESCRIPTION | PART NUMBER |
|---|---|---|

The following Flowmeter Shield part numbers apply to later madel machines with flowmeter sub-assemblies having an ORC:

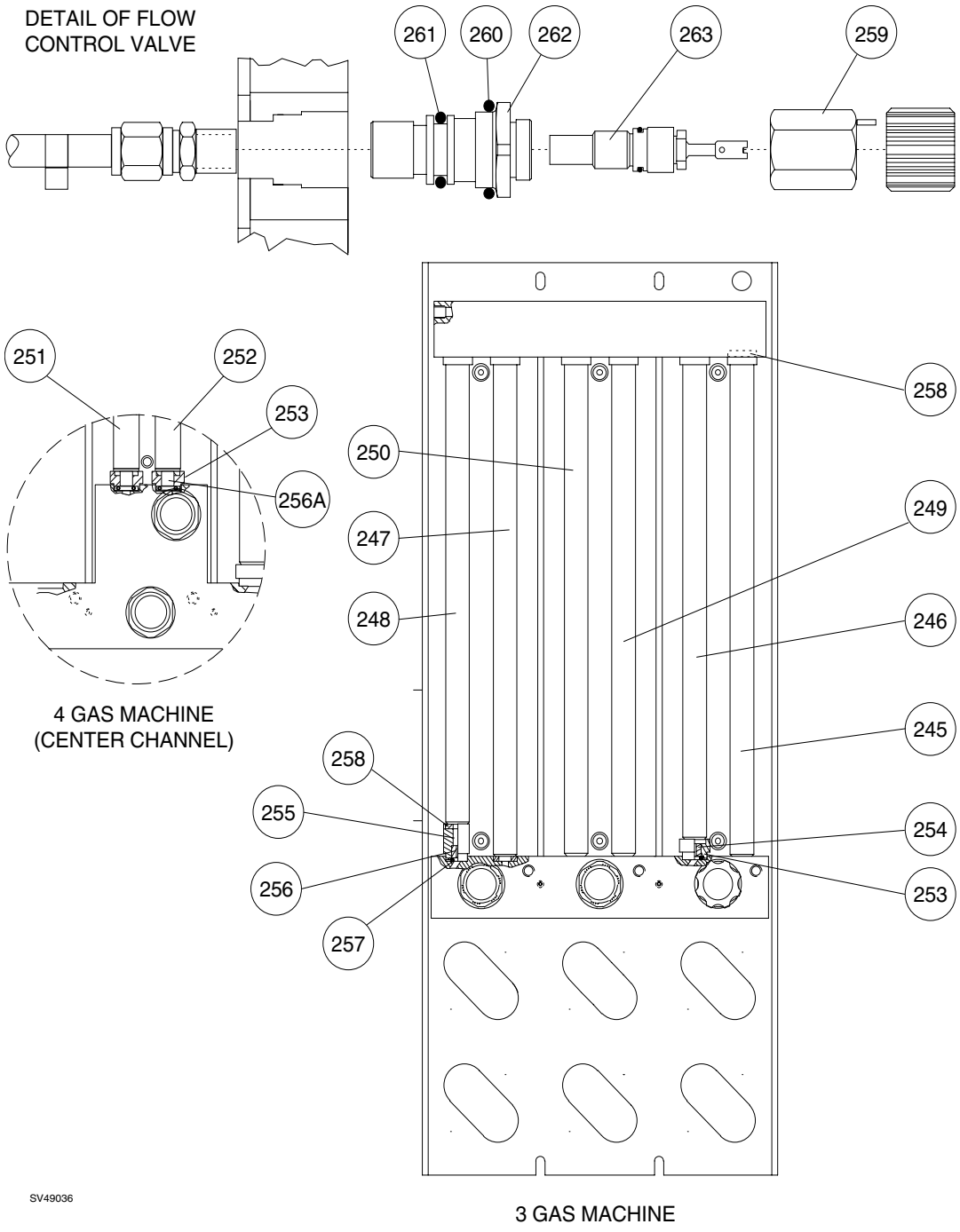
| | | |
|---|---|---|
| 235 | Shield, Flowmeter, 2 Gas $N_2O/O_2$, Domestic | 4111824-001 |
| | Shield, Flowmeter, 2 Gas $N_2O/O_2$, Canada | 4111824-002 |
| | Shield, Flowmeter, 2 Gas, Export | 4111825 |
| | Shield, Flowmeter, 3 Gas Air, Domestic | 4111830-001 |
| | Shield, Flowmeter, 3 Gas $O_2$-He, Domestic | 4111831 |
| | Shield, Flowmeter, 3 Gas Air, Canada | 4111830-002 |
| | Shield, Flowmeter, 3 Gas, Export, 6 Gauge | 4111826 |
| | Shield, Flowmeter, 3 Gas, Export, 5 Gauge | 4111827 |
| | Shield, Flowmeter, 4 Gas, Air/$CO_2$, Domestic | 4111829-003 |
| | Shield, Flowmeter, 4 Gas, Air/$O_2$-He, Domestic | 4111829-001 |
| | Shield, Flowmeter, 4 Gas, Air/$O_2$-He, Canada | 4111829-002 |
| | Shield, Flowmeter, 4 Gas, Export | 4111828 |

The following Flowmeter Shield part numbers apply to earlier machine configurations:

| | | |
|---|---|---|
| | Shield, Flowmeter, 2 Gas | 4110584-001 |
| | Shield, Flowmeter, 3 Gas (Air) | 4110585-001 |
| | Shield, Flowmeter, 2 Gas (Canada) | 4110584-002 |
| | Shield, Flowmeter, 3 Gas (Air) (Canada) | 4110585-002 |
| | Shield, Flowmeter, 4 Gas (Export) | 4111226 |
| 236 | Knob Guard, 2 Gas | 4110621 |
| | Knob Guard, 3 Gas | 4110574 |
| 237 | Screw, 6-32 x 7/16 btn hd (2x) | HW09017 |
| 238 | Knob, $O_2$ | 4103156 |
| 239 | Label, $O_2$ Flow Control Knob, Green (USA) | 4103178 |
| | White (UK, Canada) | 4105981 |
| | Blue (Germany) | 4111266-002 |
| 240 | Knob, Flow | 4103736 |
| 241 | Label, $N_2O$ Flow Control Knob, Blue (USA, UK, Canada) | 4103904 |
| | Gray (Germany) | 4111266-004 |
| | Label, Air Flow Control Knob, Yellow (USA, Germany) | 4103905 |
| | Black/White (UK, Canada) | 4105982 |
| | Label, $CO_2$ Flow Control Knob, Gray (USA,UK, Canada) | 4103908 |
| | Black (Germany) | 4111266-006 |
| | Label, $O_2$-He Flow Control Knob, Green/Brown (USA) | 4110951 |
| | White/Brown (Canada) | 4110952 |
| 242 | Gauge, 100 psi | 4110575-001 |
| | Gauge, 7.0 bar | 4110575-003 |
| 243 | Gauge, 3000 psi | 4110575-002 |
| | Gauge, 200 bar | 4110575-004 |

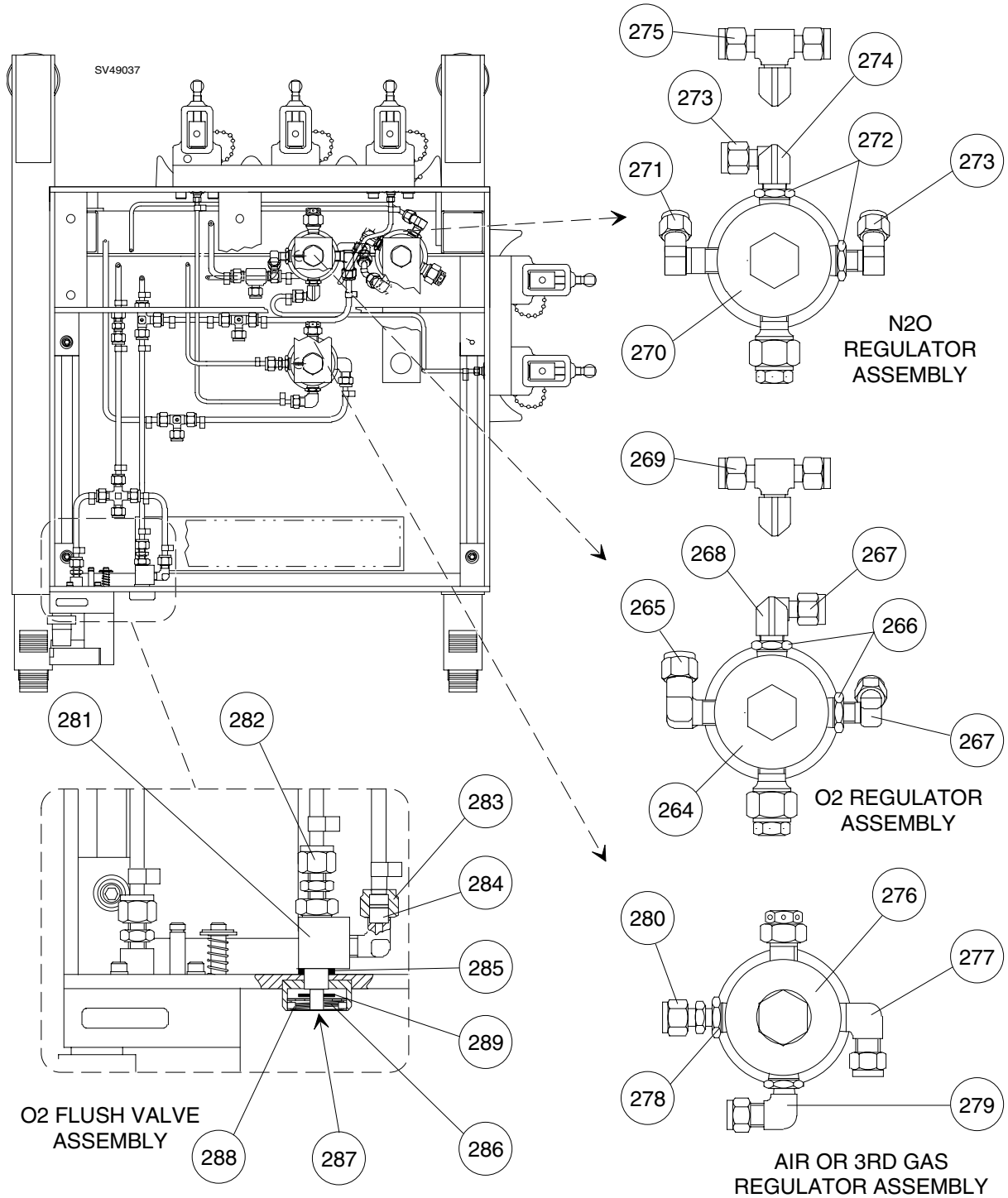
The following gauge part numbers apply to earlier machine configurations:

| | | |
|---|---|---|
| | Gauge, 100 psi O2 | 4103076 |
| | Gauge, 4000 psi O2 | 4103074 |
| | Gauge, 100 psi N2O | 4103100 |
| | Gauge, 2000 psi N2O | 4103075 |
| | Gauge Cover (old style screw-on) | 4103624 |
| 244 | Flowmeter Light Circuit Assembly | 4107370 |


DETAIL OF FLOW
CONTROL VALVE
261
260
262
263
259
251
252
253
256A
4 GAS MACHINE
(CENTER CHANNEL)
250
247
248
258
249
246
245
254
253
255
256
257
SV49036
3 GAS MACHINE

| ITEM | DESCRIPTION | PART NUMBER |
|---|---|---|
| 245 | Flow Tube, $O_2$, 1-10 l/min | 4103418 |
| | Later style w/o color band | 4112560-001 |
| | Flow Tube, $O_2$, 0.6-10 l/min (Low Flow) | 4107699 |
| | Later style w/o color band | 4112568-001 |
| 246 | Flow Tube, $O_2$, 100-1000 ml/min | 4103417 |
| | Later style w/o color band | 4112559-001 |
| | Flow Tube, $O_2$, 20-500 ml/min (Low Flow) | 4107698 |
| | Later style w/o color band | 4112567-001 |
| 247 | Flow Tube, $N_2O$, 1-10 l/min | 4103420 |
| | Later style w/o color band | 4112562-001 |
| | Flow Tube, $N_2O$, 0.6-10 l/min (Low Flow) | 4105758 |
| | Later style w/o color band | 4112564-001 |
| 248 | Flow Tube, $N_2O$, 100-1000 ml/min | 4103419 |
| | Later style w/o color band | 4112561-001 |
| | Flow Tube, $N_2O$, 20-500 ml/min (Low Flow) | 4105757 |
| | Later style w/o color band | 4112563-001 |
| 249 | Flow Tube, Air, 1-10 l/min | 4106693 |
| | Later style w/o color band | 4112566-001 |
| 250 | Flow Tube, Air, 100-1000 ml/min | 4106692 |
| | Later style w/o color band | 4112565-001 |
| 251 | Flow Tube, Air, 0.2-10 l/min (4-gas machines) | 1101084 |
| | Later style w/o color band | 4112558-001 |
| 252 | Flow Tube, $CO_2$, 0.05-1.0 l/min (4-gas machines) | 1101081 |
| | Later style w/o color band | 4112557-001 |
| | Flow Tube, $O_2$-He, 2-10 l/min (4-gas machines) | 4110956 |
| | Later style w/o color band | 4112569-001 |
| 253 | $O_2$ Restrictor Housing | 4103440 |
| 254 | $O_2$ Restrictor, Red (with ORMC or ORC) | 4110738-003 |
| 255 | $N_2O$ Restrictor Housing | 4111716 |
| 256 | $N_2O$ Restrictor, Blue (ORMC with & without wire harness) | 4110738-002 |
| | Black (machines w/ORC: E-Z Plumb) (with & without bypass) | 4110738-005 |
| 256A | Restrictor, Yellow ($CO_2$ only) | 4110738-006 |
| 257 | O-ring, #010, Neoprene (one per each restrictor housing) | 4101872 |
| 258 | Gasket, Large, 2x per Flow Tube | 4102724 |
| | Parts common to all flow control valves: | |
| 259 | Stop Pin Nut | 4103382 |
| 260 | O-ring, #018, Neoprene | 4102336 |
| 261 | O-ring, #112, Neoprene (machines w/ORC: E-Z Plumb) | 4102141 |
| | O-ring, #113, Neoprene (earlier machines) | 4102792 |
| 262 | Insert, Flow Control Valve, unplated (machines w/ORC: E-Z Plumb) | 4111819-001 |
| | plated, (4th gas only)(machines w/ORC: E-Z Plumb) | 4111819-002 |
| | Insert, Flow Control Valve (earlier machines) | 4110573 |
| 263 | Valve, Flow Control | 4103352 |
| | New part number | 4115871 |

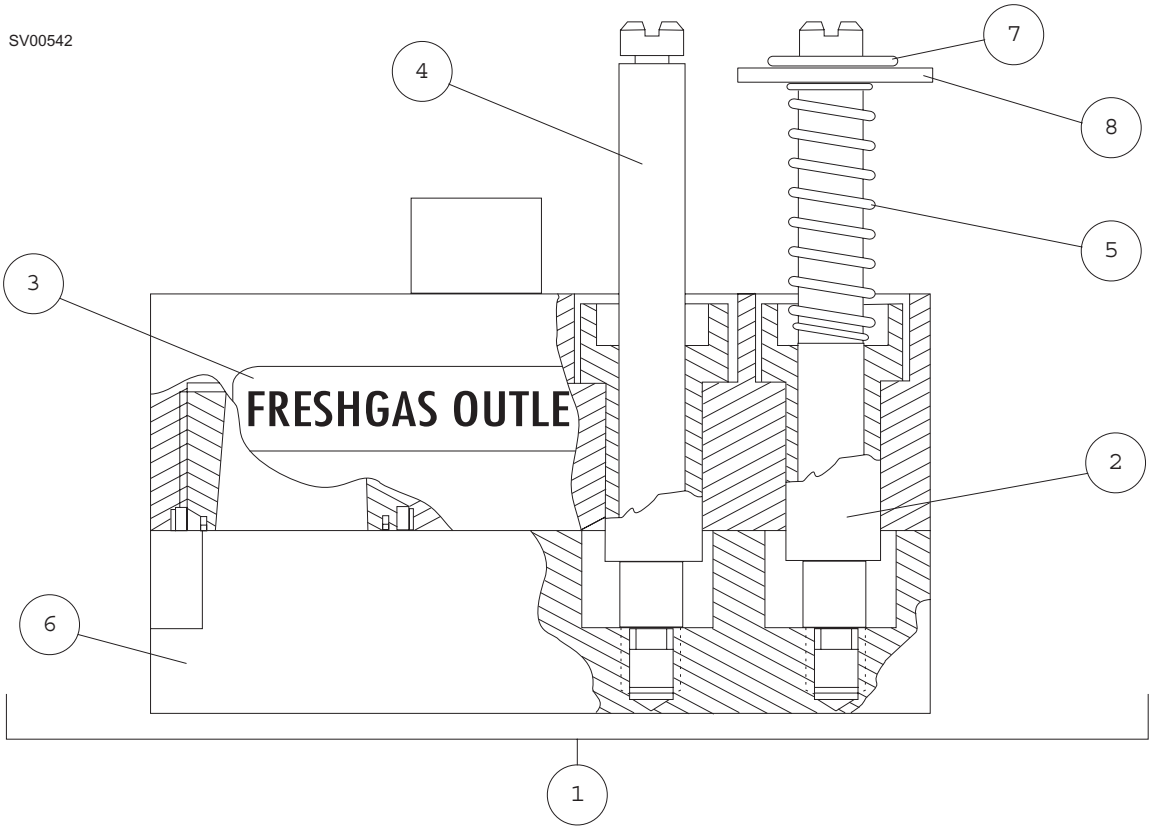
LATER MACHINE CONFIGURATIONS



| ITEM | DESCRIPTION | PART NUMBER |
|---|---|---|
| | *$O_2$ Regulator Assembly: | |
| 264 | Regulator | 4103590 |
| 265 | Elbow Fitting, ¼ Tube x ¼ MPT | 4109401 |
| 266 | Straight Fitting, ¼ MPT x ⅛ FPT (2x) | 4102906 |
| 267 | Elbow Fitting, 3/16 Tube x ⅛ MPT (2x) | 4109409 |
| 268 | Elbow Fitting, ⅛ MPT x ⅛ FPT | 4103513 |
| 269 | Tee Fitting, 3/16 Tube x 3/16 Tube x ⅛ MPT [Replaces previous two items if machine has an additional $O_2$ yoke] | 4109404 |
| | *$N_2O$ Regulator Assembly: | |
| 270 | Regulator | 4103591 |
| 271 | Elbow Fitting, ¼ Tube x ¼ MPT | 4109401 |
| 272 | Straight Fitting, ¼ MPT x ⅛ FPT (2x) | 4102906 |
| 273 | Elbow Fitting, 3/16 Tube x ⅛ MPT (2x) | 4109409 |
| 274 | Elbow Fitting, ⅛ MPT x ⅛ FPT | 4103513 |
| 275 | Tee Fitting, 3/16 Tube x 3/16 Tube x ⅛ MPT [Replaces previous two items if machine has an additional $N_2O$ yoke] | 4109404 |
| | *Air or 3rd Gas Regulator Assembly: | |
| 276 | Regulator | 4103590 |
| 277 | Elbow Fitting, ¼ Tube x ¼ MPT | 4109401 |
| 278 | Straight Fitting, ¼ MPT x ⅛ FPT (2x) | 4102906 |
| 279 | Elbow Fitting, 3/16 Tube x ⅛ MPT | 4109409 |
| 280 | Straight Fitting, 3/16 Tube x ⅛ MPT | 4109415 |
| | $O_2$ Flush Valve and Related Parts: | |
| 281 | Valve, Clippard, 2 way | 4103340 |
| 282 | Straight Fitting, ¼ Tube x ⅛ MPT | 4109408 |
| 283 | Elbow Fitting, ¼ Tube x ⅛ MPT | 4109410 |
| 284 | Restrictor, flush | 4101867 |
| 285 | Spacer | 4110792-006 |
| 286 | Button, $O_2$ FLUSH | 4103249 |
| 287 | Label, ⅝ Dot, $O_2$, Green (USA) | 4103178 |
| | White (UK, Canada) | 4105981 |
| | Blue (Germany) | 4111266-002 |
| 288 | Set Screw, 3-48 x 3/16 (2x) | HW04020 |
| 289 | Washer | 4110792-021 |

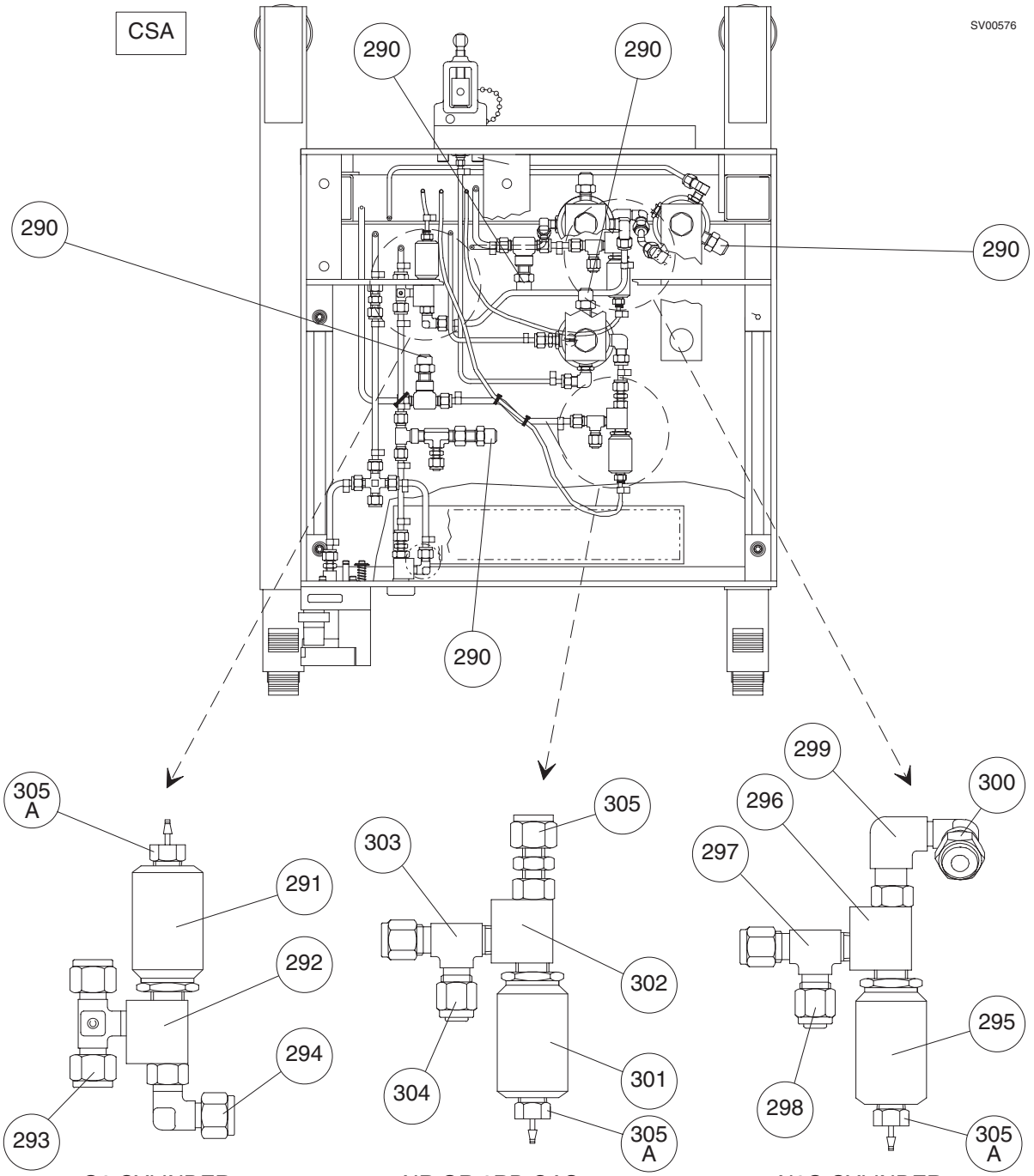
* On earlier machine configurations the regulators were listed as complete assemblies with fittings installed. Assembly numbers are listed below for reference:

| | |
|---|---|
| Regulator Assembly, $O_2$ Cylinder Pressure | 4103797 |
| Regulator Assembly, $N_2O$ Cylinder Pressure | 4103798 |
| Regulator Assembly, Air Cylinder Pressure | 4104603 |


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FRESHGAS OUTLE
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6
1

| ITEM | DESCRIPTION | PART NUMBER |
|---|---|---|
| 1 | Fresh Gas outlet assembly | 4108673 |
| 2 | Bushing, common outlet (2x) | 4108658 |
| 3 | Label, "Freshgas" | 4108666 |
| 4 | Shaft, 1/4 x 10-32 (M) x 2.88 (2x) | 4108657 |
| 5 | Spring | 4110975-002 |
| 6 | Plate, locking | 4108660-001 |
| 7 | E-clip | 4103512 |
| 8 | Spacer-R, unthreaded x 0.042 | 4110792-036 |

LATER MACHINE CONFIGURATIONS

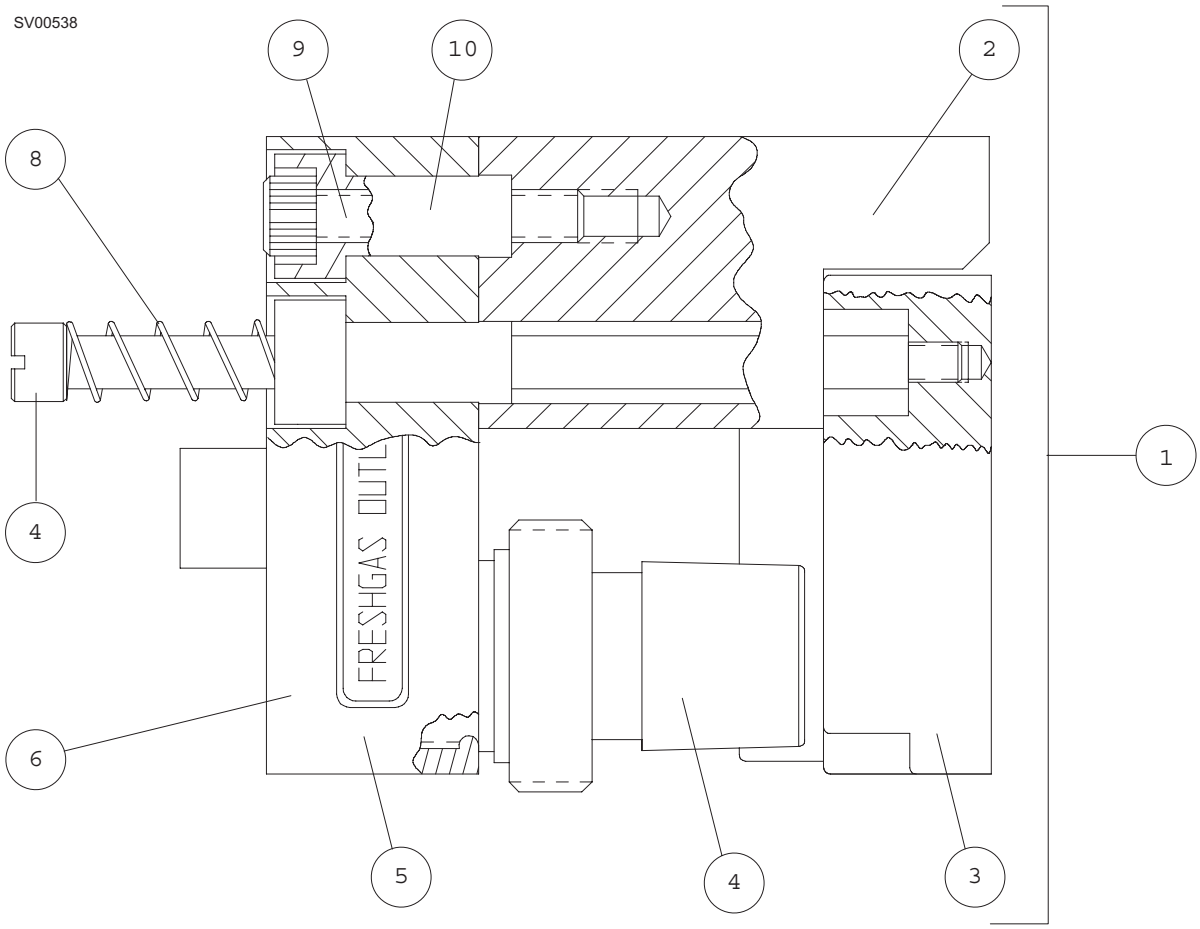


| ITEM | DESCRIPTION | PART NUMBER |
|---|---|---|
| | CSA Items: | |
| 290 | Relief Valve, 70 psi (Canada) | 4110364 |
| | *$O_2$ Cylinder Cutoff Valve Assembly (Canada) | |
| 291 | Pilot Actuator, Modified | 4106498 |
| 292 | Clippard Valve, MJVO-2 | 4106218 |
| 293 | Tee Fitting, ¼ Tube x ¼ Tube x ⅛ MPT | 4109406 |
| 294 | Elbow Fitting, ¼ Tube x ⅛ MPT | 4109410 |
| | *$N_2O$ Cylinder Cutoff Valve Assembly (Canada) | |
| 295 | Pilot Actuator, Modified | 4106498 |
| 296 | Clippard Valve, MJVO-2 | 4106218 |
| 297 | Tee Fitting, ¼ Tube x ⅛ MPT x ¼ Tube | 4109407 |
| 298 | Plug, ¼ Tube | 4103072 |
| 299 | Elbow Fitting, ⅛ MPT x ⅛ FPT | 4103513 |
| 300 | Elbow Fitting, ¼ Tube x ⅛ MPT | 4109410 |
| | *Air or 3rd Gas Cylinder Cutoff Valve Assembly (Canada) | |
| 301 | Pilot Actuator, Modified | 4106498 |
| 302 | Clippard Valve, MJVO-2 | 4106218 |
| 303 | Tee Fitting, ¼ Tube x ⅛ MPT x ¼ Tube | 4109407 |
| 304 | Plug, ¼ Tube | 4103072 |
| 305 | Straight Fitting, ¼ Tube x ⅛ MPT | 4109408 |
| 305A | Hose barb fitting, brass, 1/16 ID hose x 1/8 MPT | 4111771 |

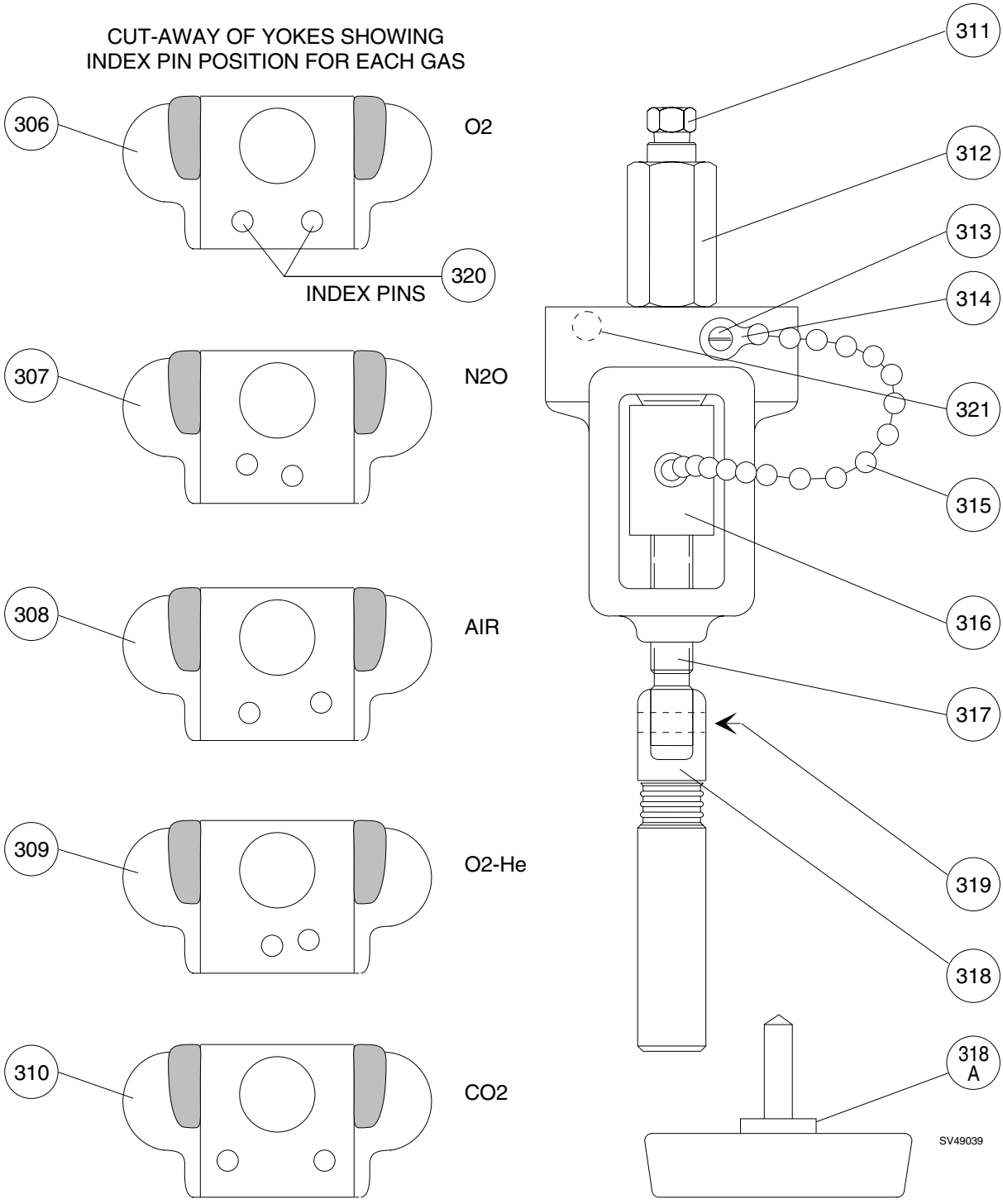
* On earlier machine configurations the cutoff valves and regulators were listed as complete assemblies with fittings installed. Assembly numbers are listed below for reference:

| | |
|---|---|
| Cylinder Cutoff Valve Assembly, $O_2$ (Canada) | 4110163 |
| Cylinder Cutoff Valve Assembly, $N_2O$ (Canada) | 4110161 |
| Cylinder Cutoff Valve Assembly, 3rd Gas (Canada) | 4110162 |
| Regulator Assembly, $O_2$ Cylinder Pressure (Canada) | 4110656 |
| Regulator Assembly, $N_2O$ Cylinder Pressure (Canada) | 4110655 |
| Regulator Assembly, He/Air/$N_2$ Cylinder Pressure (Canada) | 4110568 |
| Regulator Assembly, $CO_2$ Cylinder Pressure (Canada) | 4110657 |

## SPARE AND REPLACEMENT PARTS (continued) NM4



| ITEM | DESCRIPTION | PART NUMBER |
|---|---|---|
| 1 | Fresh Gas outlet assembly (Canada) | 4109015 |
| 2 | Block, guide | 4110707 |
| 3 | Plate, locking | 4110708-001 |
| 4 | Common outlet, 15mm x 22mm | 4109013 |
| 5 | Block, solder asm | 4108662-001 |
| 6 | Label, "Freshgas Outlet" | 4108666-001 |
| 7 | Screw, 1/4 OD x 1/4-28 x 4.6 L sltd | 4109011 |
| 8 | Spring, CPRSN, 0.36 OD x 1 3/8 L | 4110975-002 |
| 9 | Screw, 1/4-20 x 1 1/4 L, cap skt hd | HW01039 |
| 10 | Bushing | 4108658 |

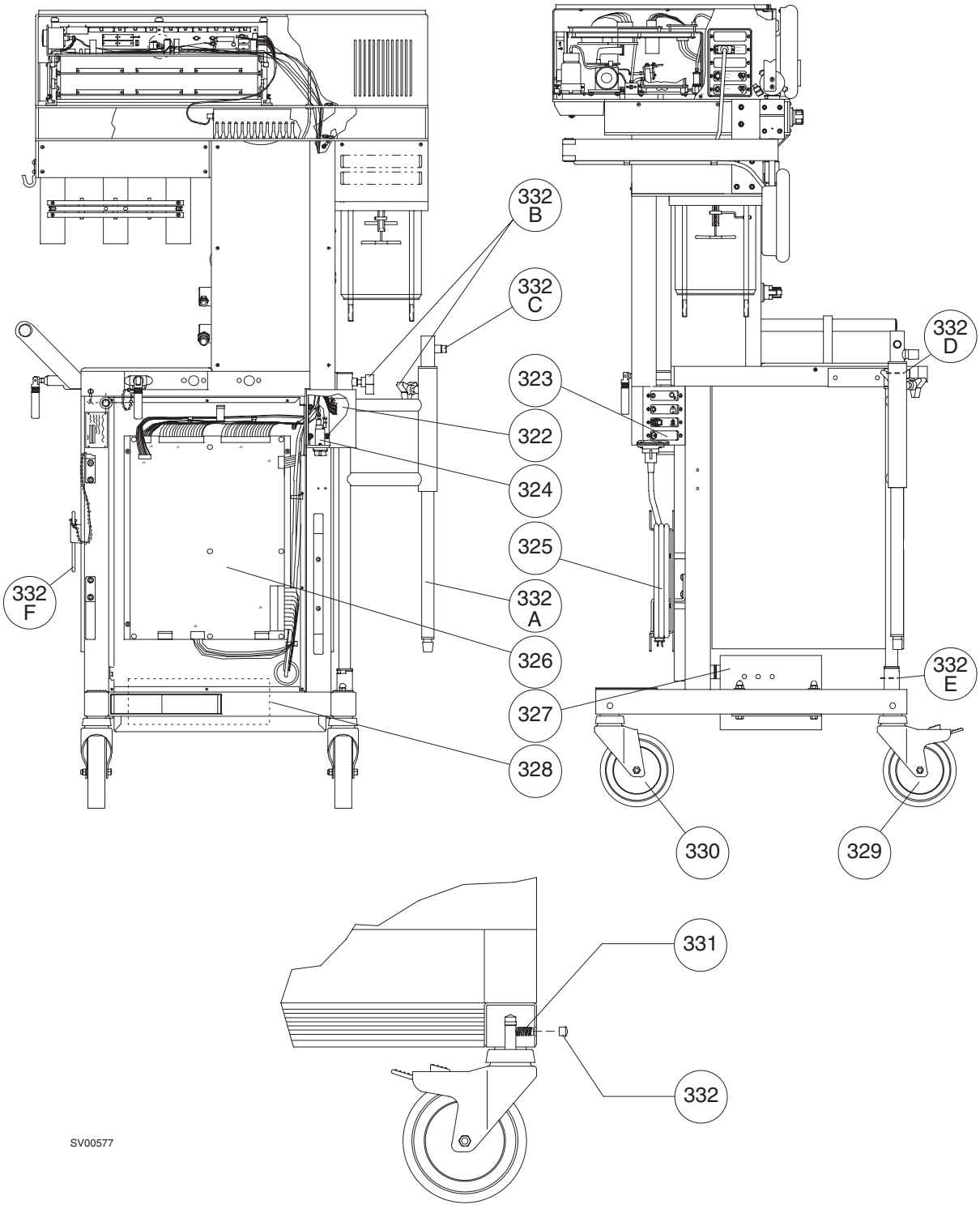

CUT-AWAY OF YOKES SHOWING
INDEX PIN POSITION FOR EACH GAS
306
O2
320
INDEX PINS
307
N2O
308
AIR
309
O2-He
310
CO2
311
312
313
314
321
315
316
317
319
318
318
A
SV49039

| ITEM | DESCRIPTION | PART NUMBER |
|---|---|---|
| 306 | Yoke, $O_2$* | 1101620 |
| 307 | Yoke, $N_2O$* | 1101621 |
| 308 | Yoke, Air* | 1101625 |
| 309 | Yoke, $O_2$-He* | 4110957 |
| 310 | Yoke, $CO_2$* | 1101624 |
| | Parts Common to All Yokes: | |
| 311 | Nut, 3/16 Tube | 4104716 |
| 312 | Check Valve Assembly | 4111792 |
| 313 | Screw, 10-32 x ⅜ in. rd hd | HW06006 |
| 314 | Chain Coupling | 4101868 |
| 315 | Chain, #10 Bead (5.75 in.) | 4103940 |
| | Items 314 and 315 superseded by Chain Assembly | 4112495-003 |
| 316 | Plug | 1101655 |
| | Plug assembly includes items 314, 315, 316 | 4112755-001 |
| 317 | Bolt, Toggle Handle | 1101556 |
| 318 | Handle | 1101595 |
| 318A | Plastic T-handle & bolt (replaces Items 317, 318, 319 on later models) | 4113536 |
| 319 | Roll Pin | HW75003 |
| 320 | Screw (Index Pin) (2x per yoke) | 4105929 |
| 321 | Yoke Labels: | |
| | Label, $O_2$, Green (USA) | 1101768 |
| | White (UK) | 4103890 |
| | Blue (Germany) | 4111266-001 |
| | Label, $N_2O$, Blue (USA, UK, Canada) | 1101619 |
| | Gray (Germany) | 4111266-003 |
| | Label, Air, Yellow (USA, Germany) | 4102742 |
| | Black/White (UK) | 4103826 |
| | Label, $O_2$-He, Green/Brown (USA) | 4110950 |
| | White/Brown (Canada) | 4110942 |
| | Label, $CO_2$, Gray (USA, UK) | 1101639 |
| | Black (Germany) | 4111266-005 |

* On earlier machine configurations the yokes were listed as complete assemblies with check valves, labels and all hardware. Assembly numbers are listed below for reference:

| | |
|---|---|
| Cylinder Yoke Assembly, $O_2$ | 1101640 |
| Cylinder Yoke Assembly, $O_2$ (Canada) | 4109943 |
| Cylinder Yoke Assembly, $N_2O$ | 1101641 |
| Cylinder Yoke Assembly, Air | 1101645 |
| Cylinder Yoke Assembly, Air (Canada) | 4109944 |
| Cylinder Yoke Assembly, $CO_2$ | 1101644 |

## SPARE AND REPLACEMENT PARTS (continued) NM4

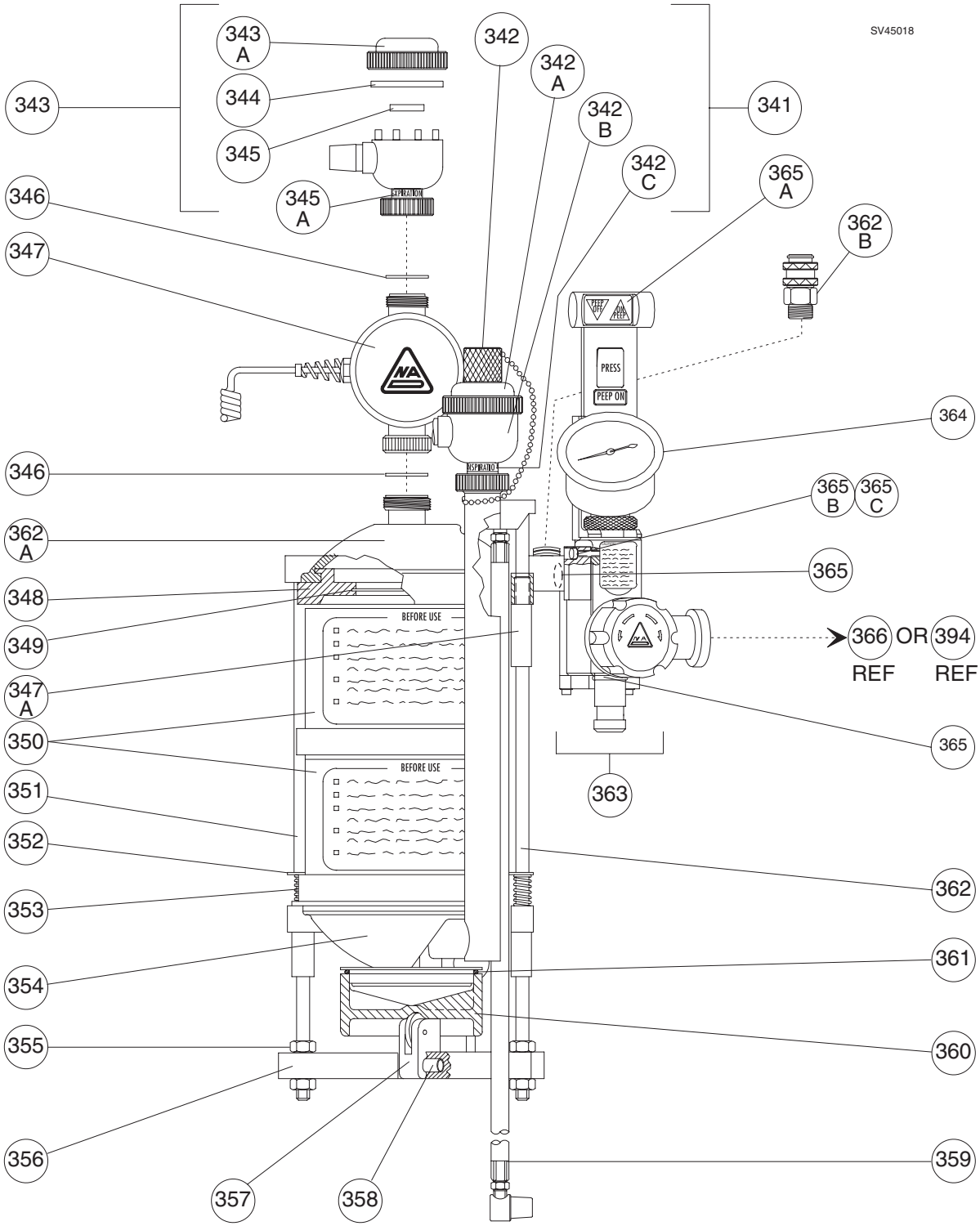


| ITEM | DESCRIPTION | PART NUMBER |
|---|---|---|
| 322 | Sensor Interface Panel (VPO) Asm (old style - not to be used w/AV2 vent) | 4111339-001 |
| | Service Exchange | SE4111339-001 |
| | Sensor Interface Panel (VPO) Assembly | 4111339 |
| | Service Exchange | SE4111339 |
| 323 | Exhaust interface panel asm. (machines w/o AV2+ ventilator) | 4108147 |
| | Man/Auto sensor and exhaust interface panel asm (machines w/AV2+ ventilator) (incl. cable to AV2+ vent. controller; does not incl fitting & tubing to gas analyzer) | 4113090-002 |
| | Panel Assembly Mounting Screws (8x) | HW09000 |
| 324 | Filter, AC Power Line (Old Part Number: 4109578) | 4112003 |
| | Filter Mounting Screws (2x) | HW09018 |
| 325 | AC Power Cord Assembly | 4109600 |
| | AC Power Cord Assembly (Export) | 4110625 |
| 326 | Power Supply Circuit Assembly | 4110505 |
| | Later replaced by | 4112323 |
| | Service Exchange | SE4112323 |
| | Power Supply Circuit Assembly (Tested) | SE4111557-001 |
| | Fuse, 250V, 5A clip type | EC00365-002 |
| | Fuse, 250V, 5A wire type | EC00366-001 |
| 327 | Power Supply Assembly, Primary | 4111301 |
| | Service Exchange | SE4111301 |
| | Circuit Breaker, 2P 5.0A (2x) | 4110537-002 |
| | Circuit Breaker, 1P w/switch 15A | 4111379-001 |
| | Power Supply Assembly, Primary, 220/240V | 4111627 |
| | Service Exchange | SE4111627 |
| | Circuit Breaker, 2P 5.0A | 4110537-002 |
| | Circuit Breaker, 1P w/switch 15A | 4111379-001 |
| 328 | Battery (4x) | 4106093 |
| 329 | Caster W/Brake (caster has base washer) (2x) (Old Part Number: 4109382) | 4111849 |
| 330 | Caster W/O Brake (caster has base washer) (2x) (Old Part Number: 4109383) (use S010135: EZ Roll, set of 4) | 4111850 |
| | Caster, 6 inch EZ Roll w/o brake | 4113006-001 |
| | Caster, 6 inch EZ Roll w/brake | 4113006-002 |
| 331 | Setscrew, Caster (4x) | HW04017 |
| 332 | Hole Plug, Setscrew (4x) | 4102729 |
| 332A | Absorber Pole | 1101724 |
| 332B | Wing Screw ⅜-16 x 1 in. | 1100078 |
| 332C | Set screw | 1101684 |
| 332D | Roll pin, 0.250 dia x 1 in. | HW75005 |
| 332E | Roll pin, 0.125 dia x 3/8 in. | HW75004 |
| 332F | Cylinder wrench | 4103737 |

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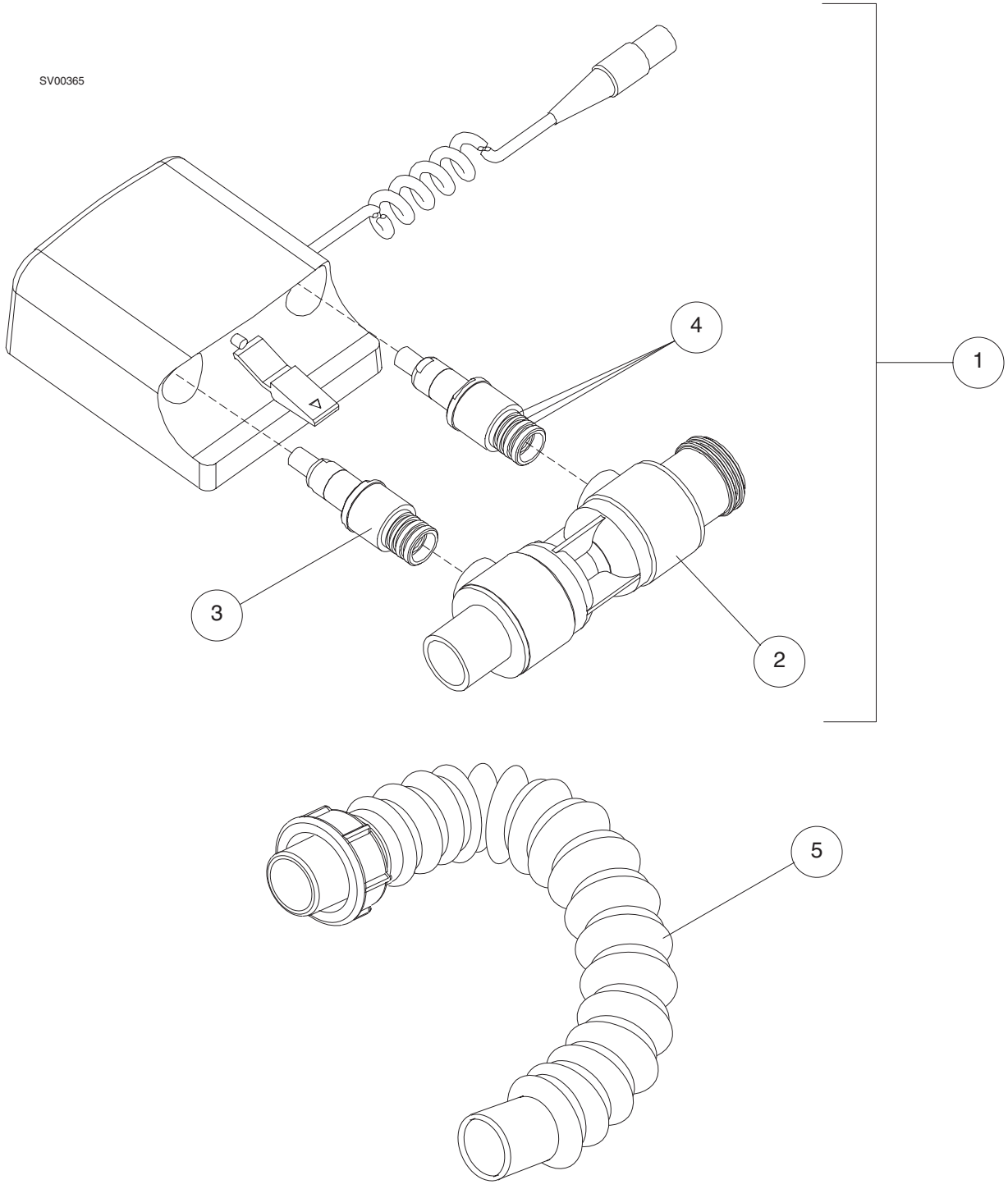
| ITEM | DESCRIPTION | PART NUMBER |
|---|---|---|
| 333 | Deleted | |
| 334 | Deleted | |
| 335 | Deleted | |
| 336 | Deleted | |
| 337 | Deleted | |
| 338 | Deleted | |
| 339 | Deleted | |
| 340 | Deleted | |

## SPARE AND REPLACEMENT PARTS (continued) NM4



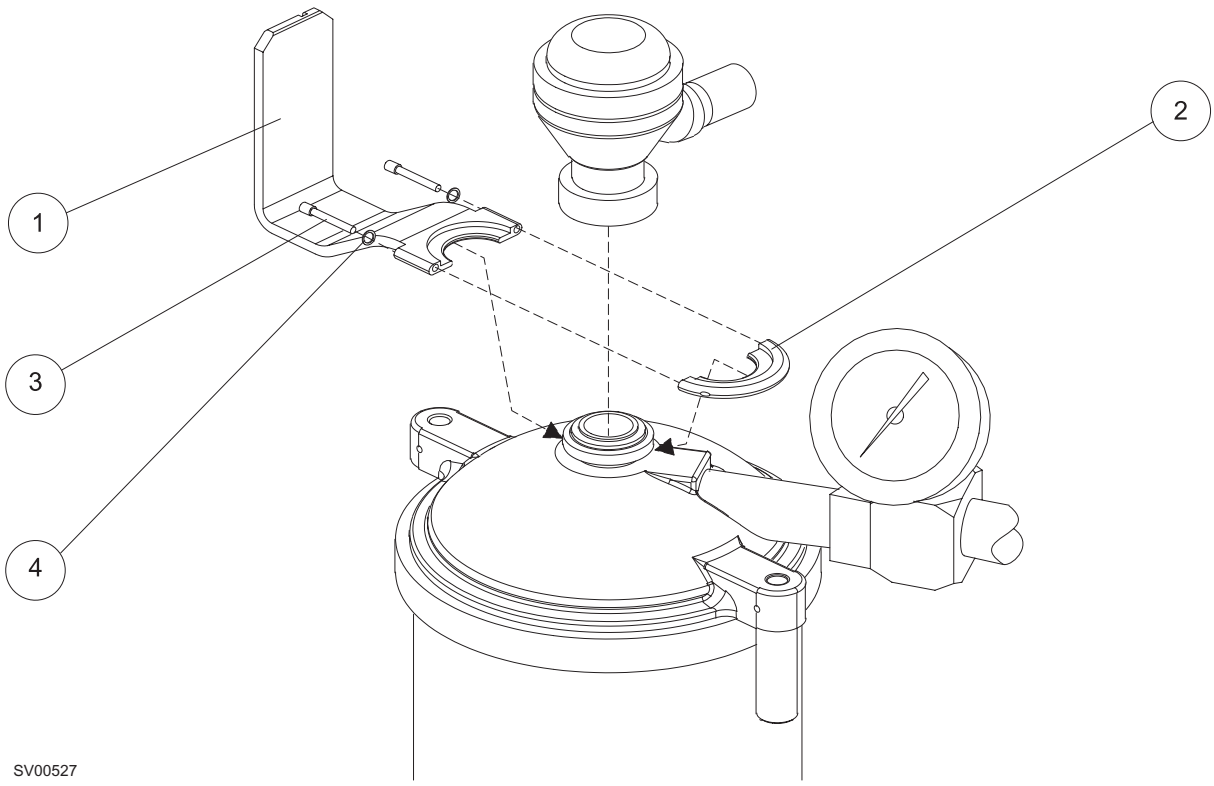
| ITEM | DESCRIPTION | PART NUMBER |
|---|---|---|
| | Absorber Assembly | 4109430 |
| | Absorber Assembly with PEEP and bypass valve | 4109431 |
| 341 | Inspiratory Valve Assembly (incl. $O_2$ sensor mount) | 4112773-001 |
| | Ref: Valve w/o $O_2$ Sensor Mount (old no.) | 2122810 |
| | (new no.) | 4112773 |
| 342 | Plug Assembly, Oxygen Sensor | 4106387 |
| 342A | Dome & Label, Insp. Valve | 4108329 |
| 342B | Valve Asm .....4112151 Service Exchange | SE4112151 |
| 342C | Label, Inspiration | 1100559 |
| 343 | Expiratory Valve Assembly (old no.) | 2122812 |
| | (new no.) | 4112150 |
| 343A | Dome | 2109230 |
| 344 | Gasket, Valve Dome (Both Valves) | 2109231 |
| 345 | Disk (Both Valves) | 2123249 |
| 345A | Label, Expiration | 1100565 |
| 346 | Gasket, Valve Mount | 1101690 |
| 347 | Spiromed Sensor .....4106362 Service Exchange | SE4106362 |
| 374A | Bushing | 1101023 |
| 348 | Gasket, Canister Top | 4105848 |
| 349 | Screen, Canister | 1100022 |
| 350 | Canister Assembly (2x) | 4105851 |
| 351 | Rod, Left | 1101356 |
| 352 | Clip, E-Ring (2x) | 1100097 |
| 353 | Spring (2x) | 4110975-010 |
| 354 | Bottom Sub-Assembly | 4108358 |
| | later replaced by | 4112932 |
| | Gasket, absorber bottom (not shown) | 1101001 |
| 355 | Nut, ⅜-16 SS (4x) | HW50010 |
| 356 | Cam Bar (2x) | 1101018 |
| 357 | Cam Assembly | 1101015 |
| 358 | Dowel Pin | 1101017 |
| 359 | Hose Assembly, Fresh Gas | 4108577 |
| 360 | Dust Cap | 4106874 |
| 361 | O-Ring | 4102940 |
| 362 | Rod, Right | 1101355 |
| 362A | Dome asm, chrome | 1101351 |
| 362B | Quick Disconnect Fitting (Breathing Pressure) | 4108139 |
| 363 | PEEP Bypass and Valve Assembly .....4111527 Service Exchange | SE4111527 |
| | Magnet assembly | 4114419 |
| | O-ring, #126 (neoprene) | 4111878 |
| | Knob | 4113558 |
| 364 | Gauge Assembly, Breathing Pressure (Incl Mtg Ring and O-Ring) | 4105853 |
| | Later design gauge assembly with additional scale in hPa | 4115275 |
| | Replacement Cover | 4113387 |
| | Replacement Ring | 4113388 |
| 365 | O-Ring, #117, Silicone (2x) | 4105766 |
| 365A | Label, PEEP OFF/ON | 4110294 |
| 365B | Screw, 8-32 x 1/2 in. | HW01014 |
| 365C | Lock Washer, #8 split | HW65001 |
| | Breathing press hose asm (quick disc. ftg on each end) | 4109368 |
| | Breathing press hose asm (quick disc. ftg one end, Luer fitting other end) | 4108528 |
| | Q-disc, w/0 valve | 4108137 |
| | Clear hose | ML08007 |
| | $O_2$ Sensor: Complete Assembly, including capsule | 4110374 |
| | Sensor Capsule: old number:. . . . . 6803290 | new number: 6850645 |
| | Housing Assembly | 4106363 |
| | Adapter (cover) | 4106385 |
| | O-ring, #025 (viton) | 4105791 |
| | O-ring, #016 (viton) (2x) | 4106388 |

## SPARE AND REPLACEMENT PARTS (continued) NM4

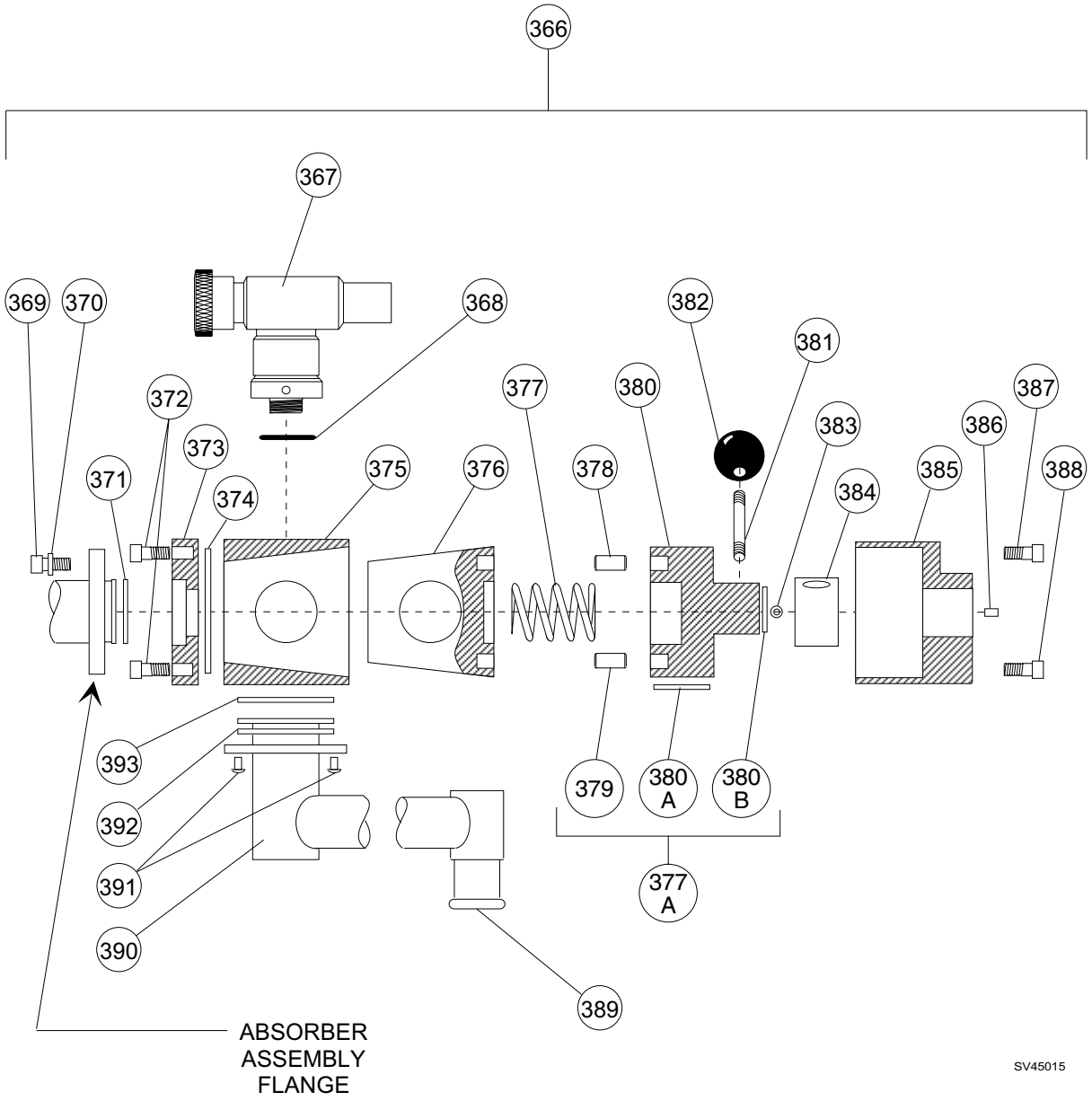


| ITEM | DESCRIPTION | PART NUMBER |
|---|---|---|
| 1 | Ultrasonic Flow Sensor Assembly | 4115754 |
| | Service Exchange part number | 4115777 |
| 2 | Flow Housing | 4114444 |
| 3 | Transducer - set of two, incl. O-rings | 4114445 |
| 4 | O-ring - set of six | 4115147 |
| 5 | Connector Hose | 4114912 |

**SPARE AND REPLACEMENT PARTS (continued)** **NM4**

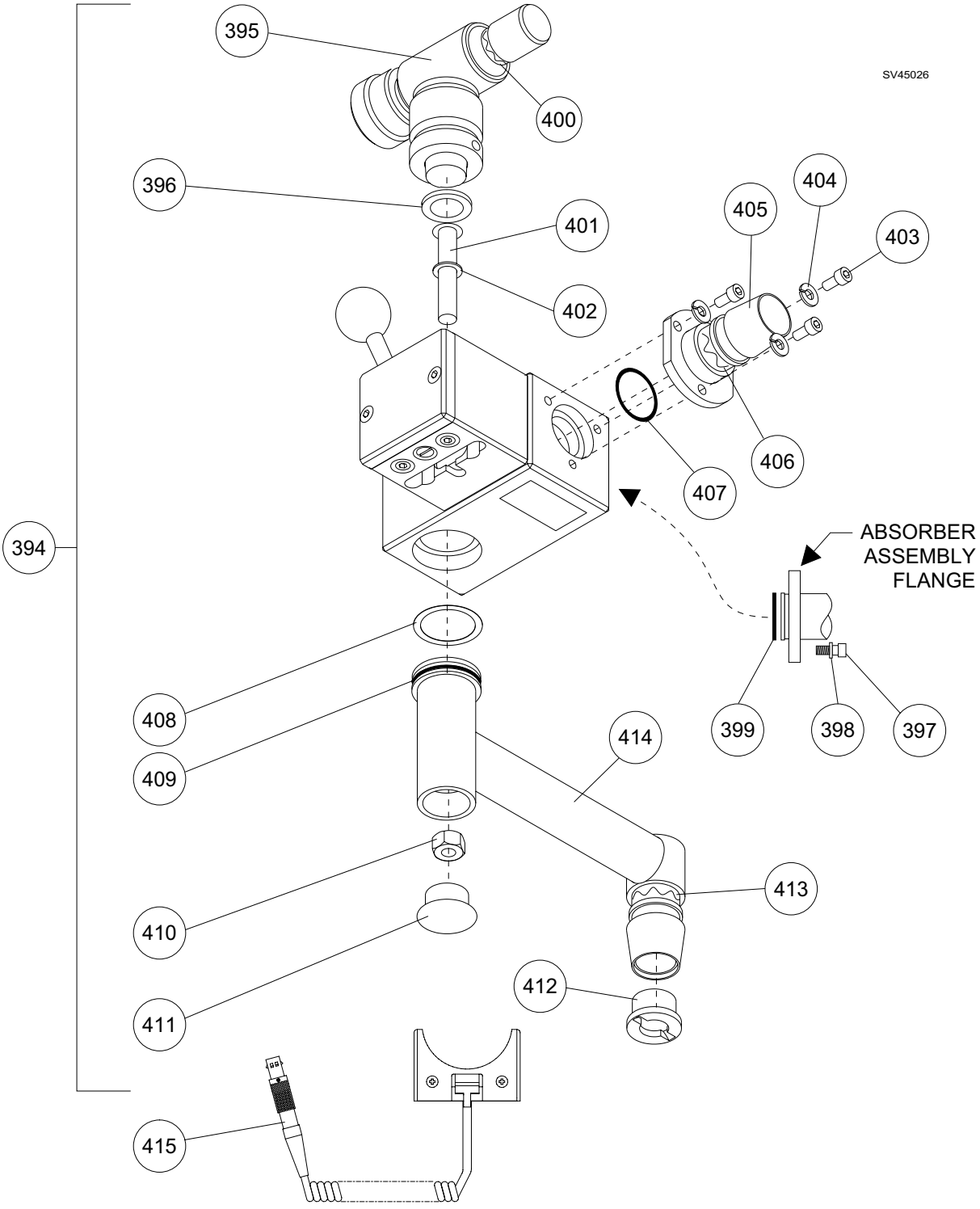


| ITEM | DESCRIPTION | PART NUMBER |
|---|---|---|
| 1. | Bracket, Flow Sensor mounting | 4114889 |
| 2. | Clamp, Flow Sensor mounting | 4114888 |
| 3. | Screw, 4-40 x 1.1 L cap skt hd (2x) | HW01103 |
| 4. | Washer, lock, split #4 | HW65000 |


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380 A
380 B
392
391
377 A
390
389
ABSORBER ASSEMBLY FLANGE
SV45015

| ITEM | DESCRIPTION | PART NUMBER |
|---|---|---|
| 366 | Valve, Man/Auto Selector | 4102698 |
| 367 | APL Valve | 4104839 |
| 368 | Fiber Washer | (Supplied with APL Valve) |
| 369 | Screw, Selector Valve Mounting, 8-32 x 7/16 in. Skt Hd Cap (3x) | HW01013 |
| 370 | Lock Washer, Selector Valve Mounting, #8 int-t (3x) | HW67000 |
| 371 | O-Ring, Neoprene | 4102941 |
| 372 | Screw, Adapter Flange Mounting, 8-32 x ½ in. (4x) | HW01014 |
| 373 | Adapter Flange | 4102694 |
| 374 | O-Ring, Silicone | 4105767 |
| 375 | Valve Housing | 4102734 |
| 376 | Valve Channel | 4102692 |
| 377 | Spring | 4110975 P-005 |
| 377A | Switch Assembly | 4102700 |
| 378 | Dowel Pin, 0.187 x ¾ in. | HW76002 |
| 379 | Dowel Pin, 0.250 x ⅝ in. | HW76003 |
| 380 | Valve Switch | 4102690 |
| 380A | Label, Bag/Auto | 4102699 |
| 380B | Label, Dot NAD | 1101098 |
| 381 | Stem | 1101011 |
| 382 | Ball | 4101848 |
| 383 | Ball Bearing (2x) | 1101637 |
| 384 | Cover | 4103118 |
| 385 | Valve Switch Block | 4102691 |
| 386 | Screw, Adjustment, ¼-28 x ¼ in. (2x) | HW04014 |
| 387 | Screw, Valve Switch Block Mounting, Upper, 8-32 x ¼ in. (2x) | HW01019 |
| 388 | Screw, Valve Switch Block Mounting, Lower, 8-32 x ½ in. (2x) | HW01020 |
| 389 | Bag Connector | 4102894 |
| 390 | Swivel Bag Mount Assembly | 1101334 |
| 391 | Screw, Bag Mount, 8-32 x ⅜ in. (4x) | HW02015 |
| 392 | O-Ring, Silicon | 4105868 |
| 393 | Glide Ring, Teflon | 1101335 |

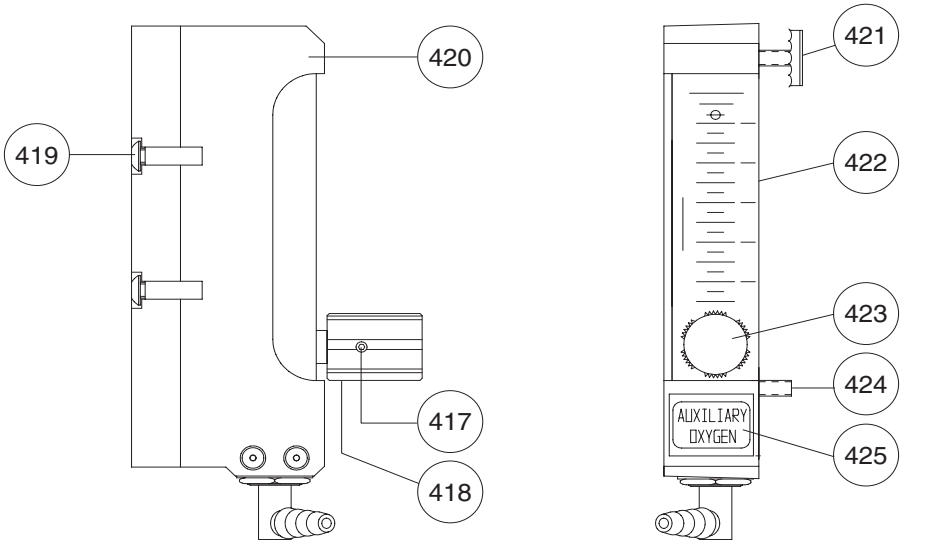
**SPARE AND REPLACEMENT PARTS (continued)** **NM4**



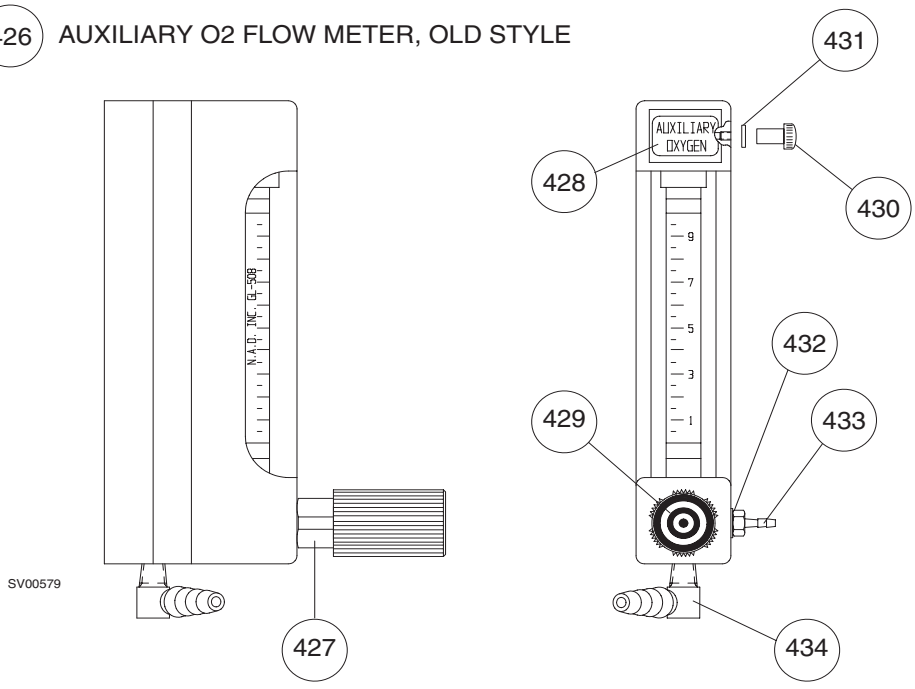
| ITEM | DESCRIPTION | PART NUMBER |
|---|---|---|
| 394 | Valve, Man/Auto Selector (later design) | 4112217-001 |
| | Service Exchange | SE4112217-001 |
| 395 | APL Valve | 4104839 |
| 396 | Fiber Washer | (Supplied with APL Valve) |
| 397 | Screw, Selector Valve Mounting, 8-32 x 7/16 in. Skt Hd Cap (3x) | HW01013 |
| 398 | Lock Washer, Selector Valve Mounting, #8 int-t (3x) | HW67000 |
| 399 | O-Ring, #117 Silicone | 4105766 |
| 400 | Label, "Scavenger Hose" | 4104806 |
| 401 | Screw, 5/16-18 x 3¾ in. Rd Hd | HW06023 |
| 402 | Spacer | 4110792-070 |
| 403 | Screw, 8-32 x 7/16 in. Skt Hd Cap (3x) | HW01013 |
| 404 | Lock Washer, #8 split (3x) | HW65011 |
| 405 | Connector Assembly, 22mm | 4106744 |
| 406 | Label, "Ventilator Hose" | 1100563 |
| 407 | O-Ring, #117 Silicone | 4105766 |
| 408 | Spacer | 4110792-071 |
| 409 | O-Ring, #120 EPDM | 4112629-001 |
| 410 | Nut, 5/16-18 Hexseal | 4112613-001 |
| 411 | Hole Plug, 3/16 in. dia. | 4111663-001 |
| 412 | Bag Connector | 4102894 |
| 413 | Label, "Breathing Bag" | 1100561 |
| 414 | Bag Mount Assembly | 4112622-001 |
| 415 | Sensor Cord Asssembly (for AV2+ ventilator) | 4113126 |

Form, PMS, NM4 Anesthesia System ..... S010052

416 AUXILIARY O2 FLOW METER, NEW STYLE

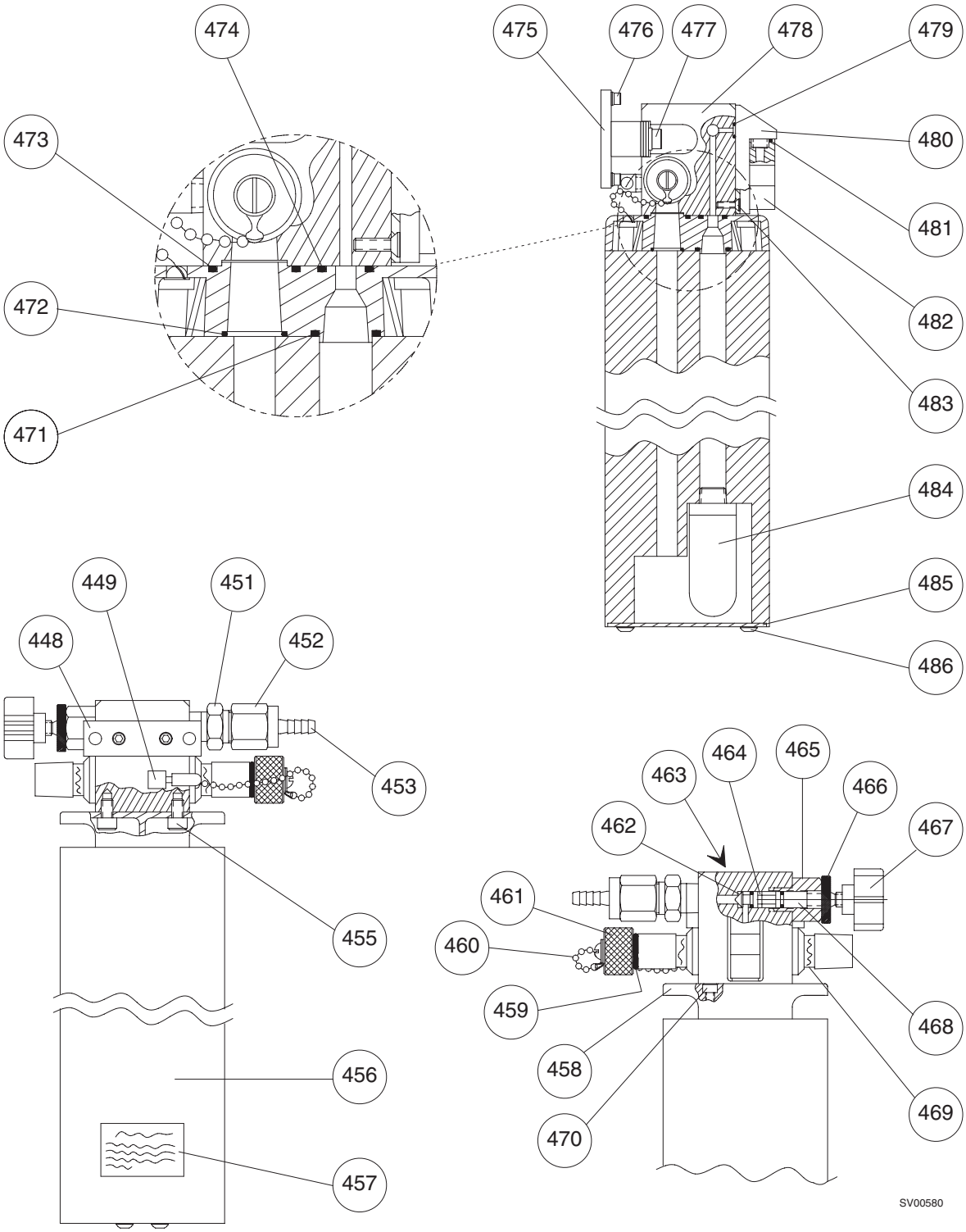



426 AUXILIARY O2 FLOW METER, OLD STYLE



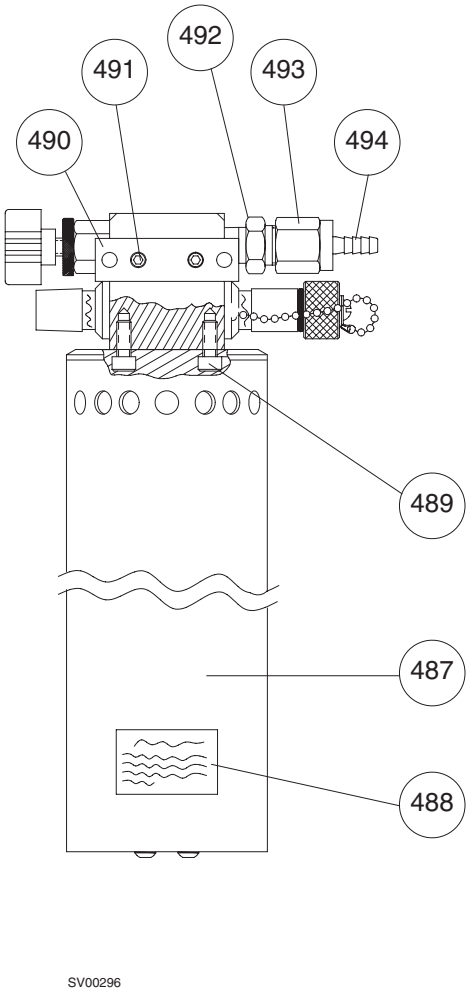
| ITEM | DESCRIPTION | PART NUMBER |
|---|---|---|
| 416 | Auxiliary $O_2$ Flow Meter Assembly, new style | 4109310 |
| 417 | Set Screw, cup point, 6-32 x ¼ in. | HW04003 |
| 418 | Knob | 4111442 |
| 419 | Screw, 10-32 x 1 1/16 in. btn hd (2x) | HW09043 |
| 420 | Housing | 4111053 |
| 421 | Kep nut, 10-32 | HW55002 |
| 422 | Flowmeter (incl. tube & valve) | 4111460 |
| 423 | Label, ⅝ w/dot and green & white rings | 4109373 |
| 424 | Set Screw, cup point, 10-32 x ⅞ (2x) (used as mtg stud) | HW04011 |
| 425 | Label, AUXILIARY OXYGEN | 4109381 |
| 426 | Auxiliary $O_2$ Flow Meter Assembly, old style | 4109391 |
| 427 | Valve, flow control, sub-compact | S0B7271 |
| 428 | Label, AUXILIARY OXYGEN | 4109381 |
| 429 | Label, ⅝ w/dot and green & white rings | 4109373 |
| 430 | Screw, 10-32 x 5/8 in. cap skt hd | HW01027 |
| 431 | Flat washer, #10 | HW66003 |
| 432 | Fiber washer | 4102165 |
| 433 | Hose barb ftg, 10-32 x 1/16 hose | 4103445 |
| 434 | Ell, 3/16 hose | 4109387 |
| 435 | Deleted | |
| 436 | Deleted | |
| 437 | Deleted | |
| 438 | Deleted | |
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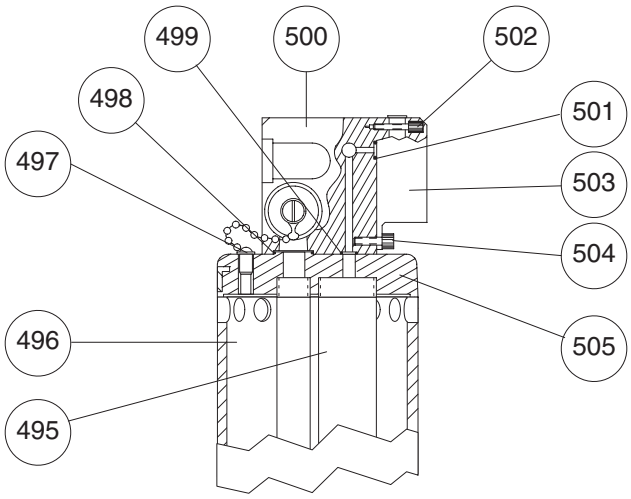
## SPARE AND REPLACEMENT PARTS (continued) NM4

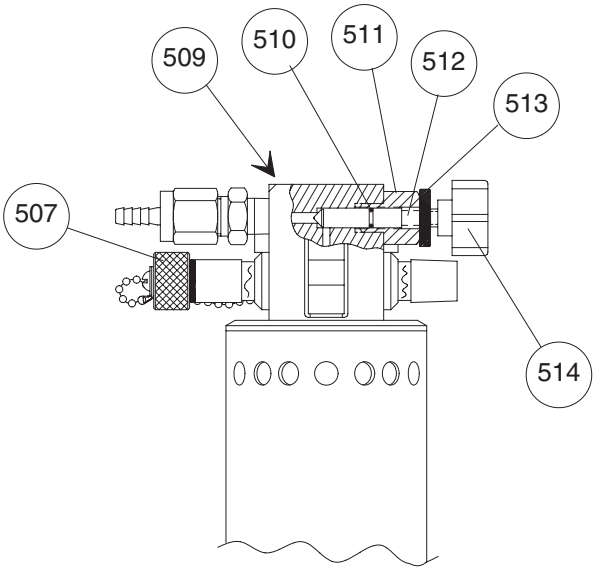


| ITEM | DESCRIPTION | PART NUMBER |
|---|---|---|
| | Open Reservoir Scavenger Assembly | 4107624 |
| 448 | Mounting Bracket | 4109314 |
| 449 | Elbow, ⅛ M x ¼ in. hose | 4106881 |
| 450 | Deleted | |
| 451 | Body, DISS VAC x ¼ MPT | 4103669 |
| 452 | Nut, DISS VAC | 4103122 |
| 453 | Hose Barb Nipple | 4103123 |
| 454 | Deleted | |
| 455 | Screw, ¼-20 x ⅜ in. skt hd (2x) | HW01033 |
| 456 | Reservoir | 4110982 |
| 457 | Label, CAUTION | 4104294 |
| 458 | Reservoir Top | 4110979 |
| 459 | O-ring #112 (neoprene) | 4102141 |
| 460 | Chain, 8¼ lg | 4112495-005 |
| 461 | Plug | 4102140 |
| 462 | O-ring #008 (neoprene) | 4102022 |
| 463 | Label, ACTIVATE HOSPITAL VACUUM | 4109305 |
| 464 | Retaining Ring | 4110997 |
| 465 | Nut, Valve Stem Retainer | 4109316 |
| 466 | Lock Nut, ⅜-24 | 4112137 |
| 467 | Wing Nut | 4105699 |
| 468 | Spindle | 4112138 |
| 469 | Label, SCAVENGER HOSE (2x) | 4104806 |
| 470 | Screw, 10-32 x ¾ in. skt hd (4x) | HW01028 |
| 471 | O-ring #019 (neoprene) | 4106458 |
| 472 | O-ring #015 (neoprene) | 4104602 |
| 473 | O-ring #019 (neoprene) | 4106458 |
| 474 | O-ring #013 (neoprene) | 4102234 |
| 475 | Bracket Assembly | 4106231 |
| 476 | Screw, 10-32 x ½ in. skt hd (2x) | HW01025 |
| | Lock Washer, #10 split (2x) | HW65003 |
| | Flat Washer, #10 (2x) | HW66003 |
| 477 | Screw, ¼-20 x ½ in. skt hd (2x) | HW01034 |
| | Lock Washer, ¼ int-t (2x) | HW67005 |
| 478 | Block | 4111002 |
| 479 | O-ring, #008 (neoprene) | 4102022 |
| 480 | Flowmeter Housing | 4110980 |
| 481 | O-ring, #012 (neoprene) | 1101523 |
| 482 | Flowmeter | 4112289 |
| 483 | Screw, 6-32 x ⅜ in. flat hd (2x) | HW05006 |
| 484 | Silencer | 4110999 |
| 485 | Reservoir Cap | 4111000 |
| 486 | Screw, 10-32 x ⅜ in. btn hd (4x) | HW09005 |

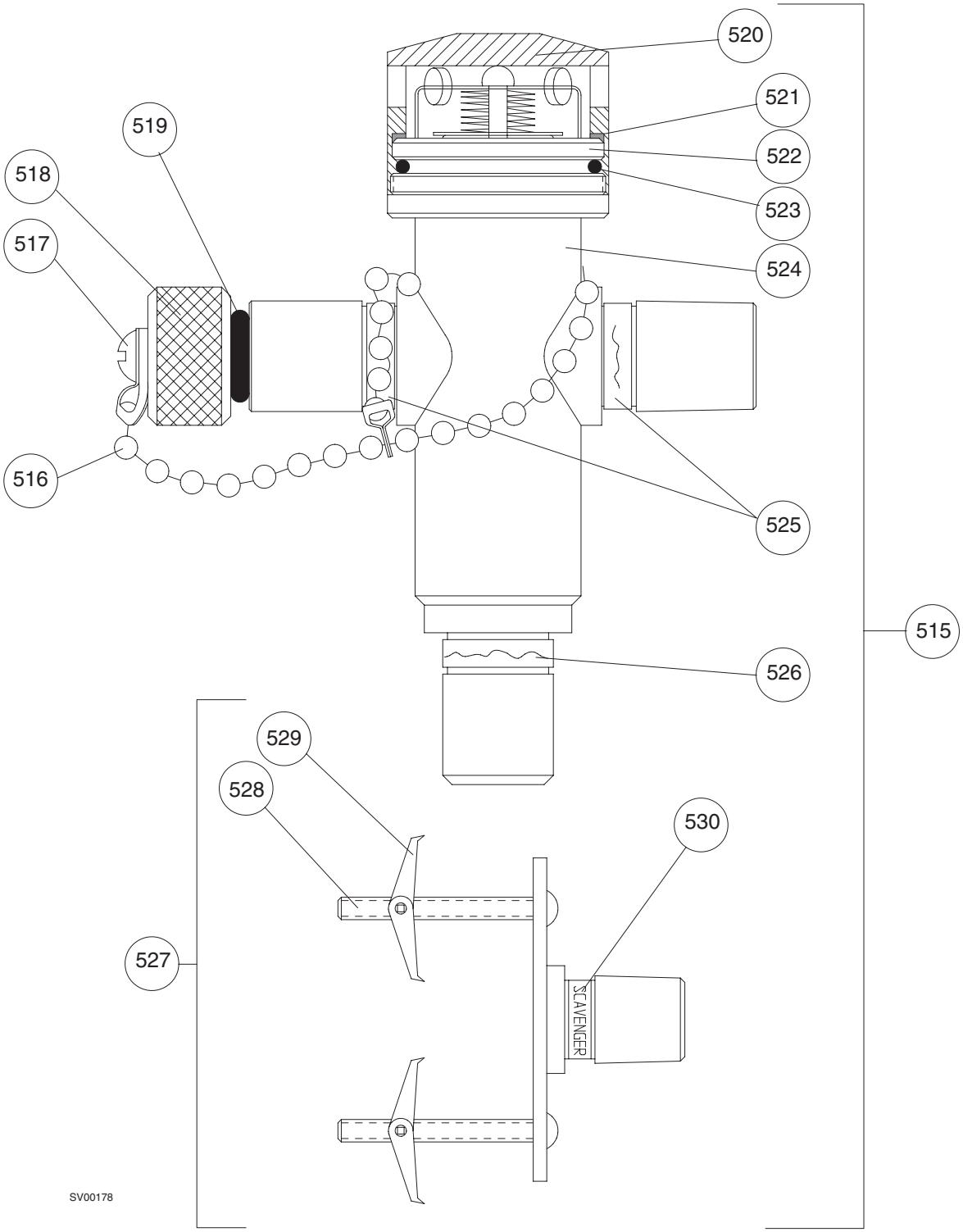
## SPARE AND REPLACEMENT PARTS (continued) NM4



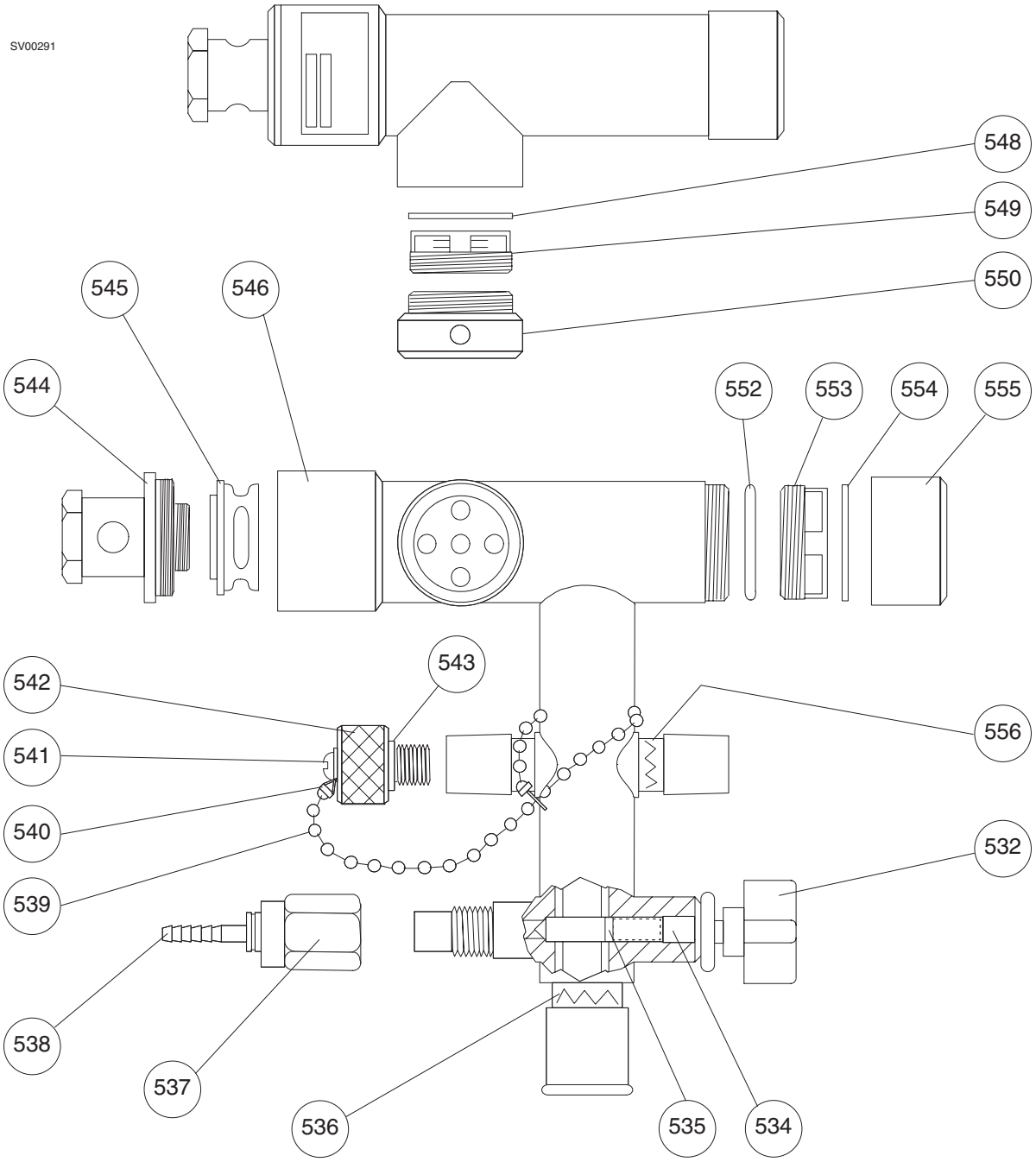



| ITEM | DESCRIPTION | PART NUMBER |
|---|---|---|
| | Open Reservoir Scavenger Assembly, old style | 4109321 |
| 487 | Reservoir Assembly | 4109320 |
| 488 | Label, CAUTION... | 4104294 |
| 489 | Screw, cap skt hd, ¼-20 x ¾ in. (2x) | HW01036 |
| 490 | Mounting Bracket | 4109314 |
| 491 | Screw, flat hd, 8-32 x ¾ in. (2x) | HW03026 |
| 492 | DISS body x ¼ MPT | 4103669 |
| 493 | DISS nut | 4103122 |
| 494 | Hose barb | 4103123 |
| 495 | Tube, 1 in. dia | 4109312 |
| 496 | Tube, ¾ in. dia | 4109311 |
| 497 | Screw, btn hd, 10-32 x ⅜ in. | HW09005 |
| 498 | O-ring, #016 neoprene | 4109322 |
| 499 | O-ring, #010 neoprene | 4101872 |
| 500 | Block | 4109309 |
| 501 | O-ring, #008 neoprene | 4102022 |
| 502 | Screw, cap skt hd, 6-32 x ⅝ in. | HW01067 |
| 503 | Flowmeter | 4109306 |
| 504 | Screw, cap skt hd, 6-32 x ¼ in. | HW01007 |
| 505 | Top, Scavenger Reservoir | 4109307 |
| 506 | Deleted | |
| 507 | Plug assembly | 4102098 |
| 508 | Deleted | |
| 509 | Label, ACTIVATE HOSPITAL VACUUM | 4109305 |
| 510 | O-ring, #008 neoprene | 4102022 |
| 511 | Nut, valve stem retainer | 4109316 |
| 512 | Spindle | 4102068 |
| 513 | Lock nut, ⅜-24 | 4105990 |
| 514 | Wing nut | 4105699 |


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| ITEM | DESCRIPTION | PART NUMBER |
|---|---|---|
| 515 | Scavenger, A/C | 4106161 |
| 516 | Chain assembly, 8¼ in. | 4112495-006 |
| 517 | Screw, round hd, 10-32 x ½ in. | HW06007 |
| 518 | Plug | 4102140 |
| 519 | O-ring, #112 neoprene | 4102141 |
| 520 | Dust cover | 1101527 |
| 521 | Spacer | 4110792-007 |
| 522 | Valve 'A' 5 cm $H_2O$ | 2207032 |
| 523 | O-ring, #027 neoprene | 4101871 |
| 524 | Body, solder assembly | 4102105 |
| 525 | Label, SCAVENGER HOSE (2x) | 4104806 |
| 526 | Label, EXHAUST | 4106878 |
| 527 | Vent Grill Adapter (for 19 mm hose) | 1101312 |
| 528 | Screw, round hd, 10-24 x 3 in. (2x) | HW06012 |
| 529 | Toggle nut (2x) | 4101862 |
| 530 | Label, SCAVENGER HOSE | 4104806 |
| 531 | Deleted | |
| | Hose Barb Adapter | 4108114 |

## SPARE AND REPLACEMENT PARTS (continued) NM4



| ITEM | DESCRIPTION | PART NUMBER |
|---|---|---|
| | Suction Scavenger | 4102088 |
| 532 | Wing nut | 4105699 |
| 533 | Deleted | |
| 534 | Spindle | 4102068 |
| 535 | O-ring, #008 neoprene | 4102022 |
| 536 | Label, RESERVOIR BAG | 4106879 |
| 537 | DISS nut | 4103122 |
| 538 | Hose barb | 4103123 |
| 539 | Bead Chain, 8¼ in. | 4103940 |
| 540 | Chain coupling (2x) | 4101868 |
| 541 | Screw, round hd, 10-32 x ½ in. | HW06007 |
| 542 | Plug | 4102140 |
| 543 | O-ring, #112 neoprene | 4102141 |
| 544 | Cap assembly | 4104659 |
| 545 | 'A' Valve, 1.8 cm $H_2O$ | 2116219 |
| 546 | Housing assembly | 4104755 |
| 547 | Deleted | |
| 548 | Seal, 'A' valve | 4106321 |
| 549 | 'A' Valve, 0.5 cm $H_2O$ | 7264277 |
| 550 | Dust cap | 4102036 |
| 551 | Deleted | |
| 552 | O-ring, #215 neoprene | 4102038 |
| 553 | 'A' Valve, 5 cm $H_2O$ | 2207032 |
| 554 | Spacer | 4110792-007 |
| 555 | Dust cap | 4102035 |
| 556 | Label, SCAVENGER HOSE (2x) | 4104806 |

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# Narkomed 4 Service Manual

## Rev. AB summary of changes

| Page | Description |
|---|---|
| 6-1 thru 6-49 | Entire section revised to reflect PMC nomenclature |

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